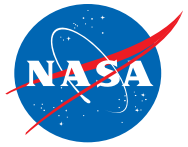
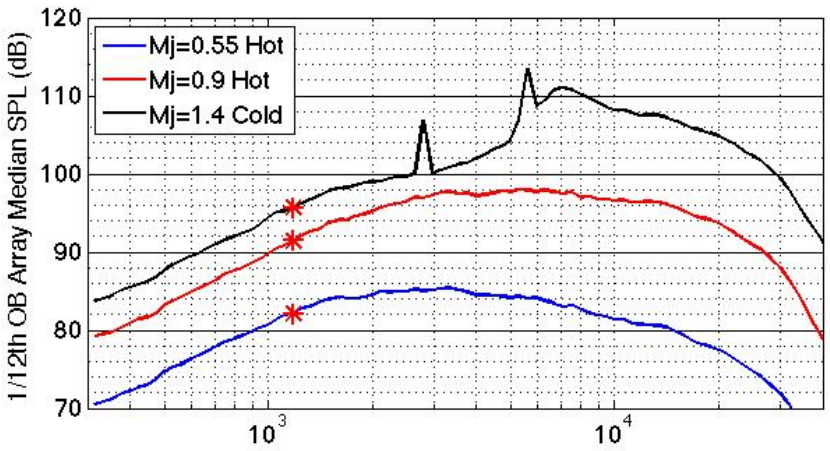


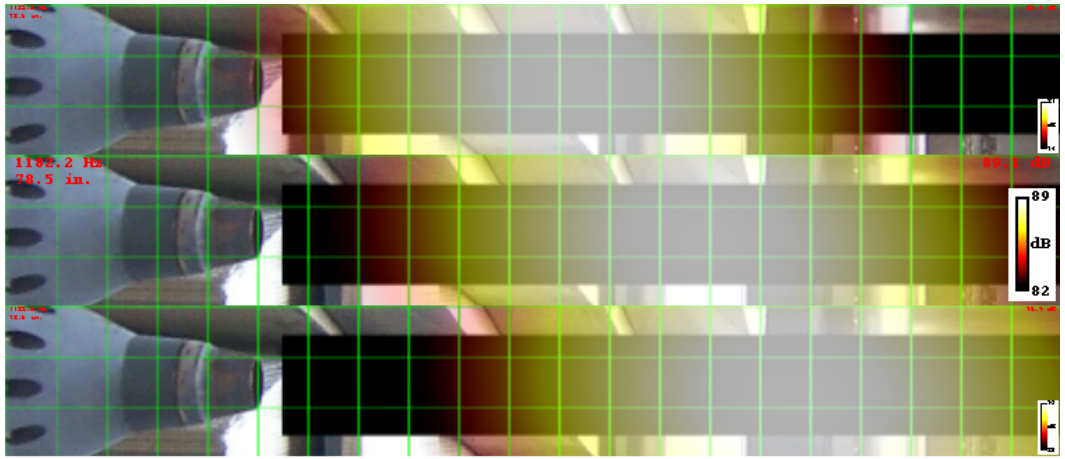
Comparison of Noise Source Localization Data with Flow Field Data Obtained in Cold Supersonic Jets and Implications Regarding Broadband Shock Noise

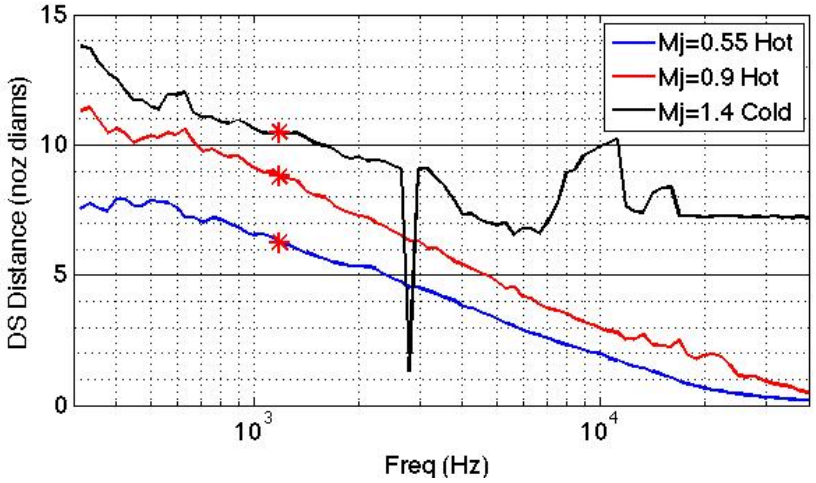
Gary Podboy NASA GRC
Mark Wernet NASA GRC
Michelle Clem NASA GRC
Amy Fagan NASA GRC

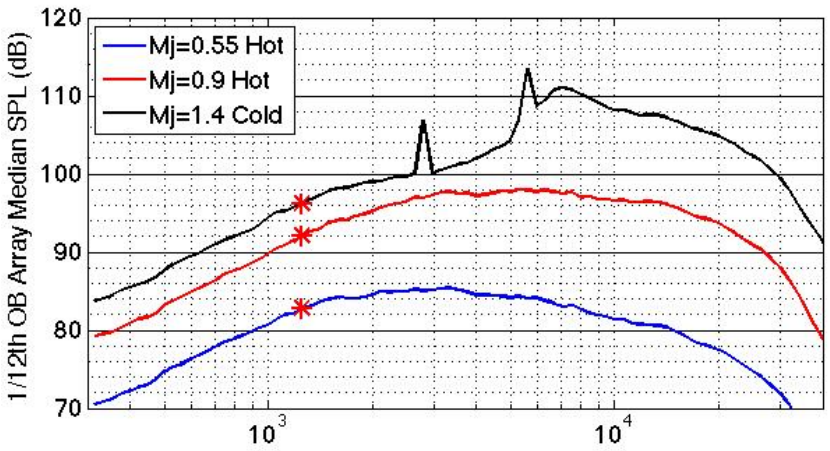
Acoustics Technical Working Group
April 23 - 24, 2013

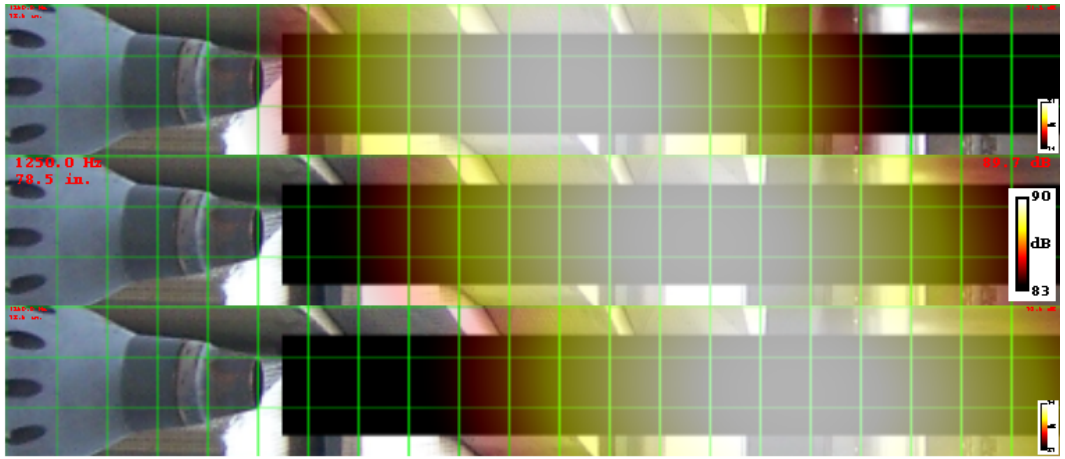
Support Provided by the Fixed Wing Project

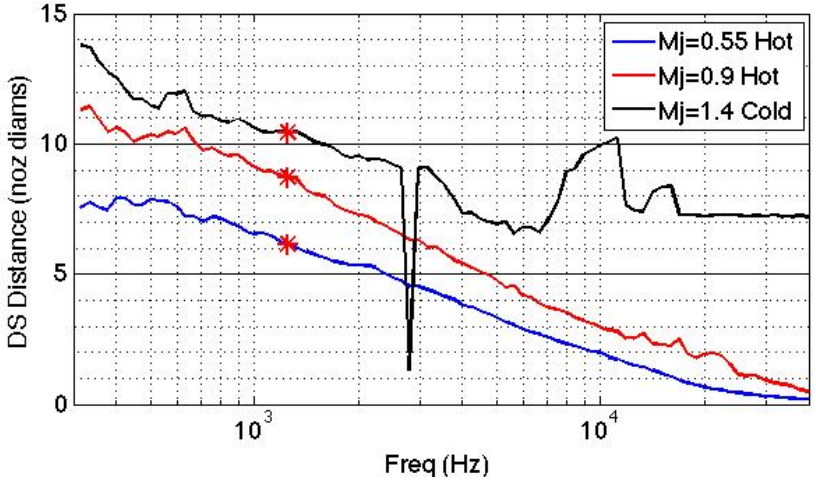

Mj=0.55 Hot
Mj=0.9 Hot
Mj=1.4 Cold
1/12th OB Array Median SPL (dB)
120
110
100
90
80
70
10^3
10^4

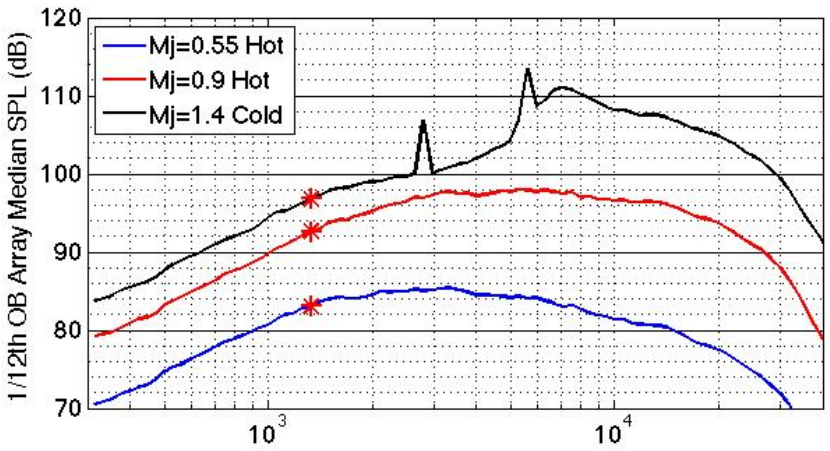

1102.2 Hz
78.5 in.
89
dB
82

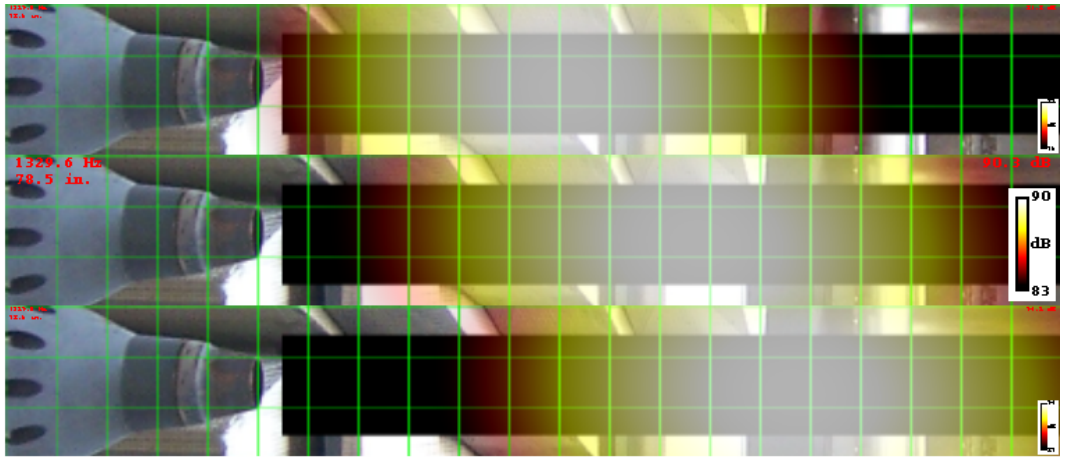

Mj=0.55 Hot
Mj=0.9 Hot
Mj=1.4 Cold
DS Distance (noz diams)
15
10
5
0
10^3
10^4
Freq (Hz)

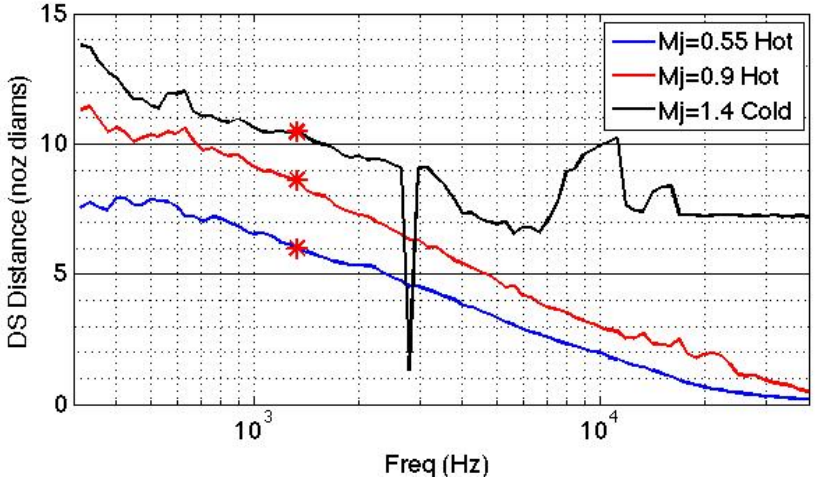

Mj=0.55 Hot
Mj=0.9 Hot
Mj=1.4 Cold
1/12th OB Array Median SPL (dB)
120
110
100
90
80
70
10^3
10^4

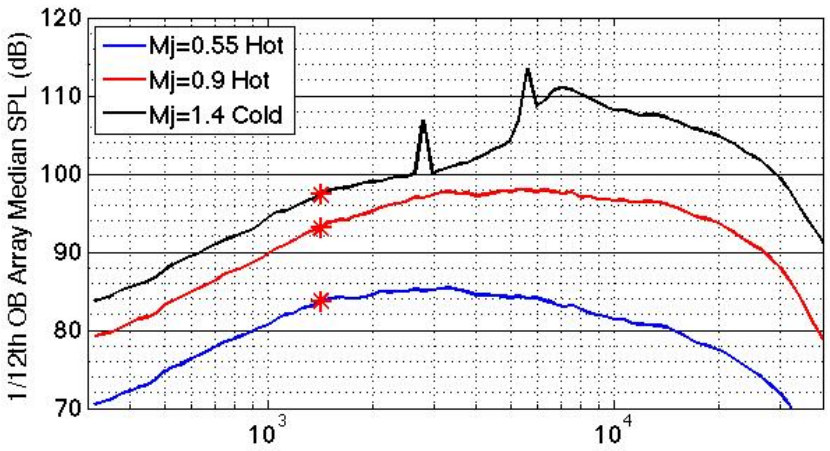

1250.0 Hz
78.5 in.
90
dB
83

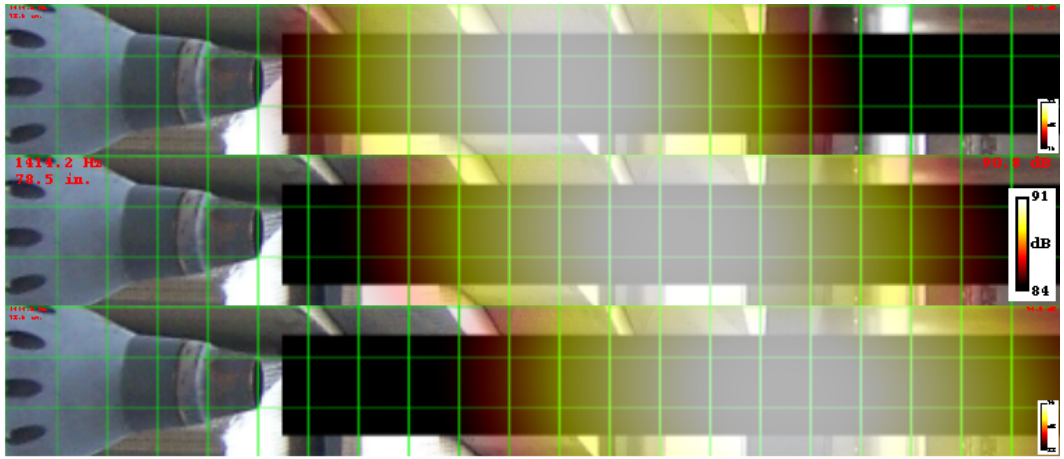

Mj=0.55 Hot
Mj=0.9 Hot
Mj=1.4 Cold
DS Distance (noz diams)
15
10
5
0
10^3
10^4
Freq (Hz)

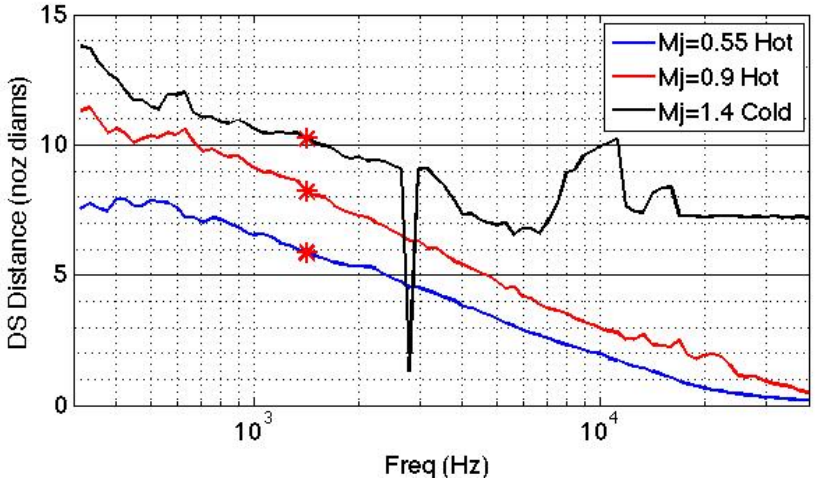

Mj=0.55 Hot
Mj=0.9 Hot
Mj=1.4 Cold
1/12th OB Array Median SPL (dB)
120
110
100
90
80
70
10^3
10^4

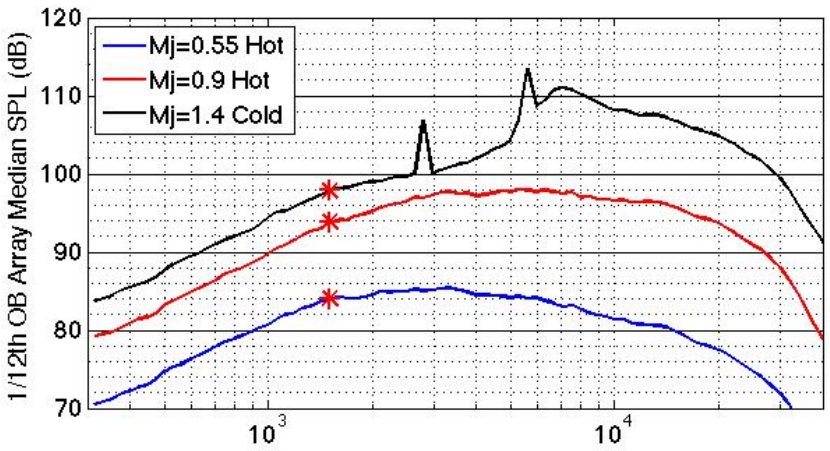

1329.6 Hz
78.5 in.
90
dB
83

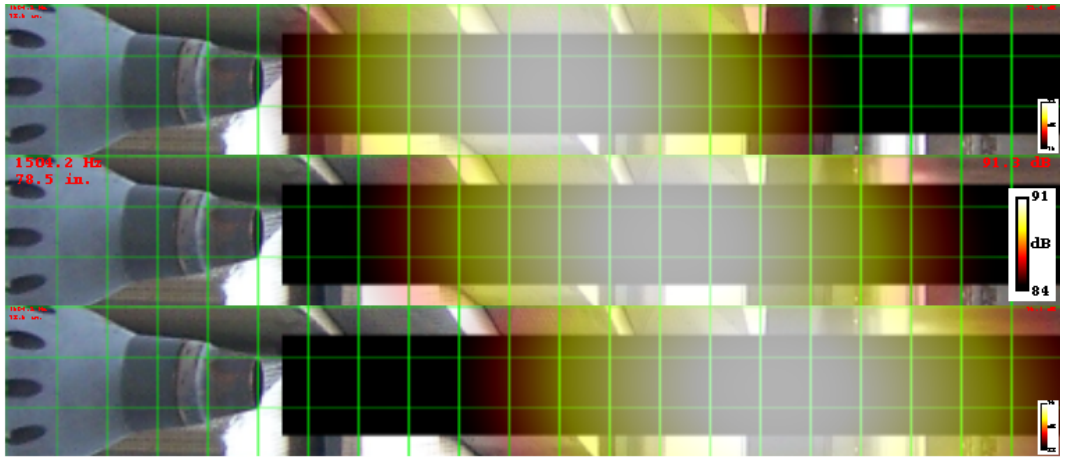

Mj=0.55 Hot
Mj=0.9 Hot
Mj=1.4 Cold
DS Distance (noz diams)
15
10
5
0
10^3
10^4
Freq (Hz)

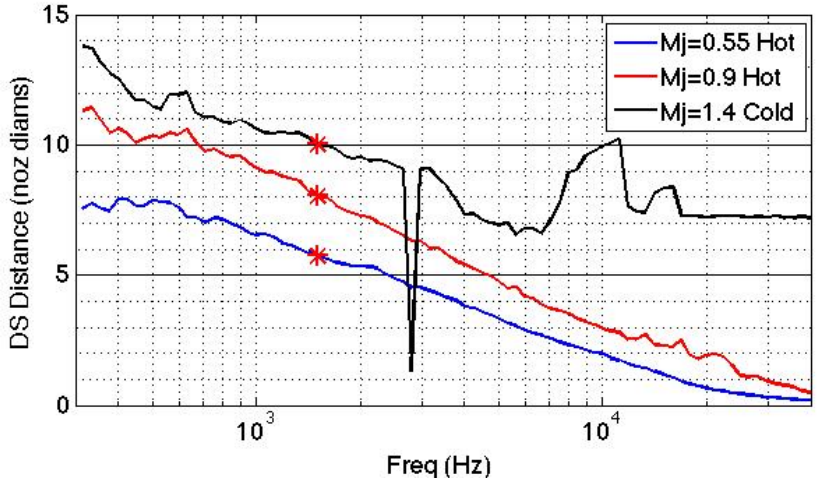

Mj=0.55 Hot
Mj=0.9 Hot
Mj=1.4 Cold
1/12th OB Array Median SPL (dB)
120
110
100
90
80
70
10^3
10^4

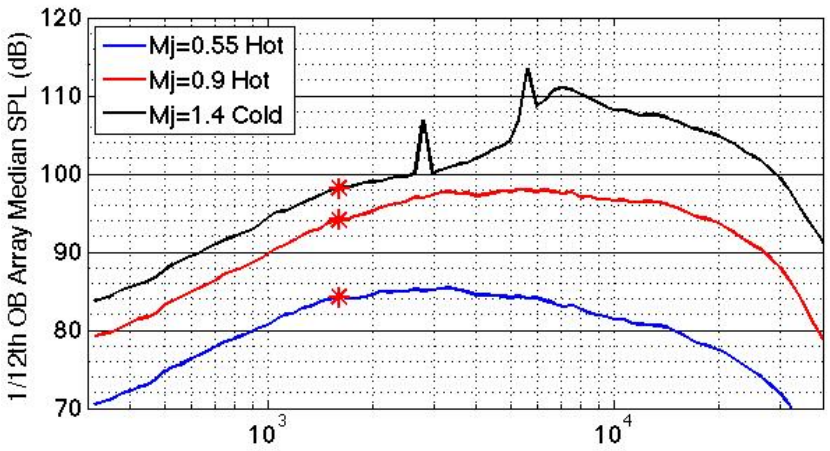

1414.2 Hz
78.5 in.
91
dB
84

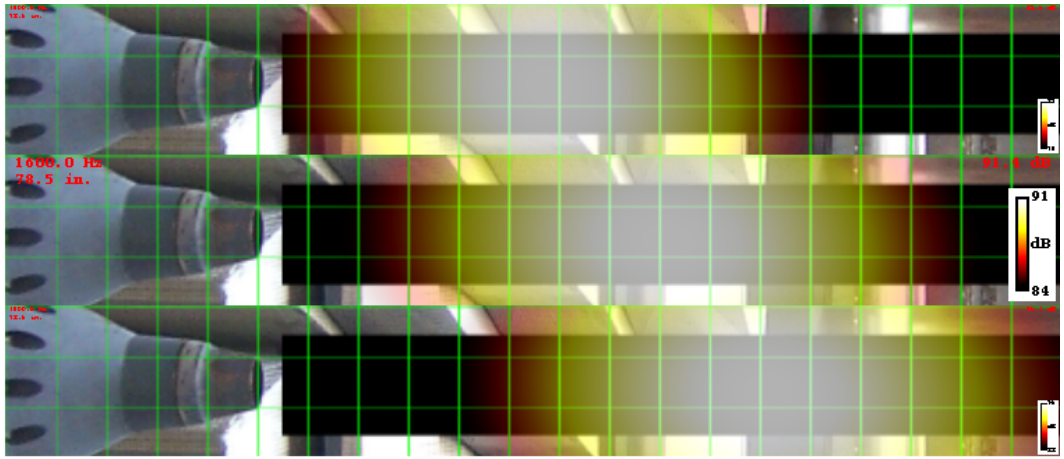

Mj=0.55 Hot
Mj=0.9 Hot
Mj=1.4 Cold
DS Distance (noz diams)
15
10
5
0
10^3
10^4
Freq (Hz)

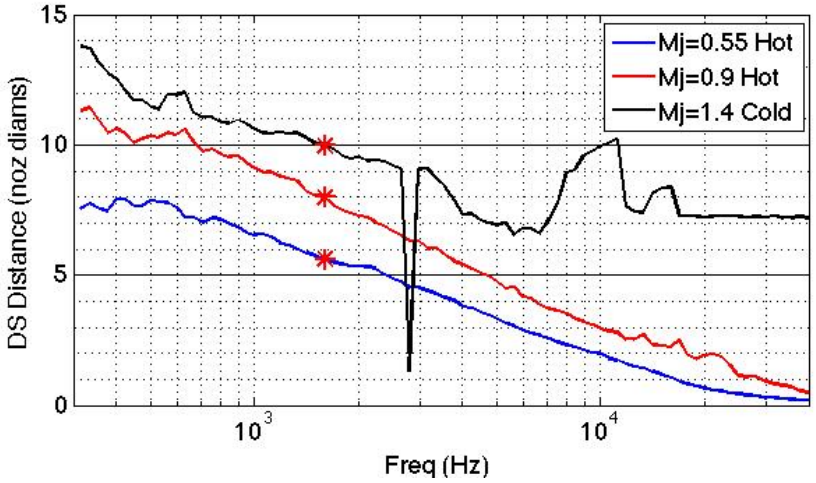

Mj=0.55 Hot
Mj=0.9 Hot
Mj=1.4 Cold
1/12th OB Array Median SPL (dB)
120
110
100
90
80
70
10^3
10^4

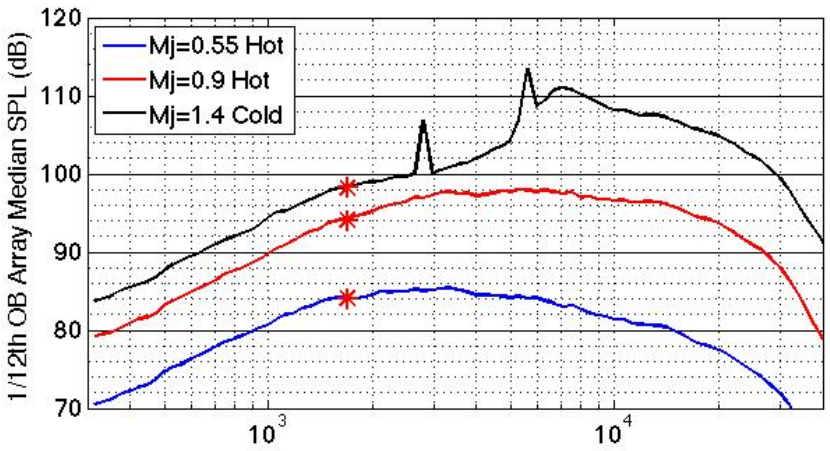

1500.2 Hz
78.5 in.
91
dB
84

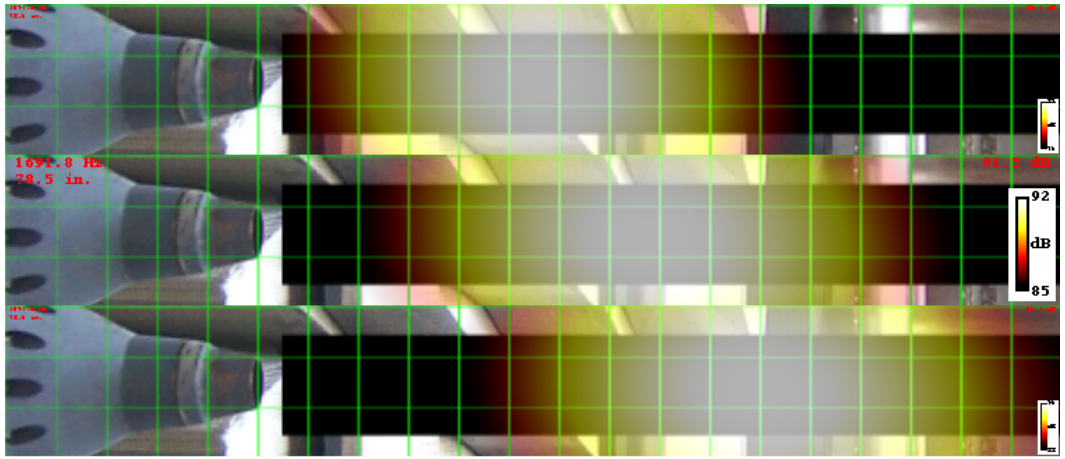

Mj=0.55 Hot
Mj=0.9 Hot
Mj=1.4 Cold
DS Distance (noz diams)
15
10
5
0
10^3
10^4
Freq (Hz)

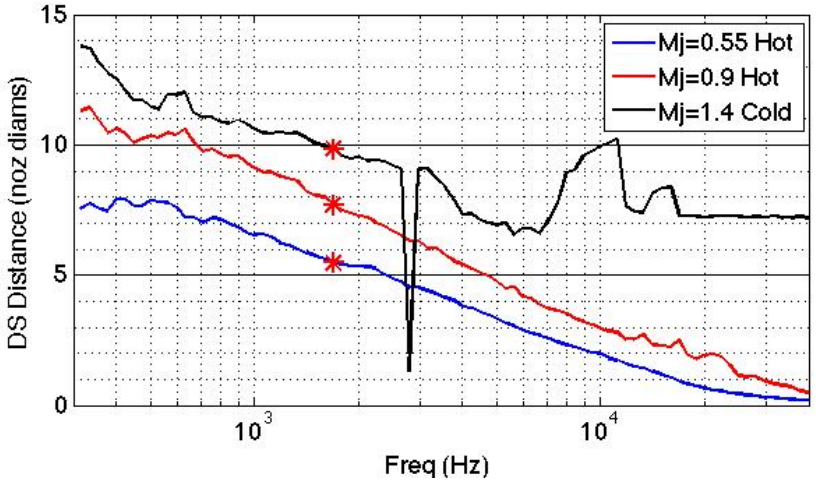

Mj=0.55 Hot
Mj=0.9 Hot
Mj=1.4 Cold
1/12th OB Array Median SPL (dB)
120
110
100
90
80
70
10^3
10^4

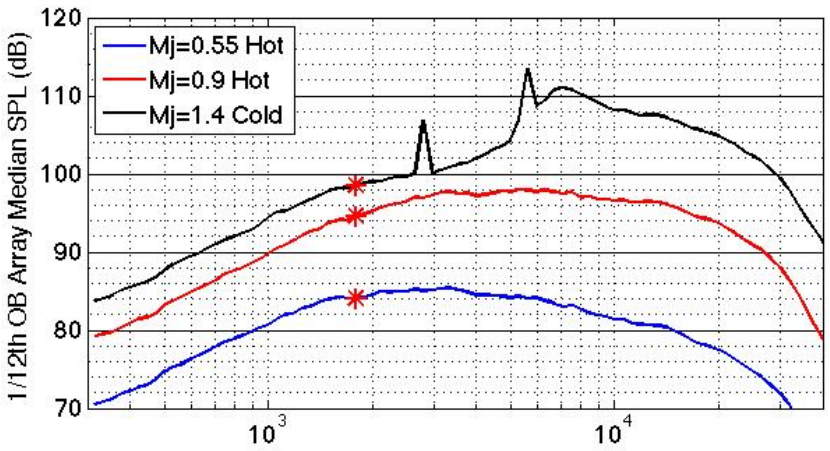

1600.0 Hz
78.5 in.
91
dB
84

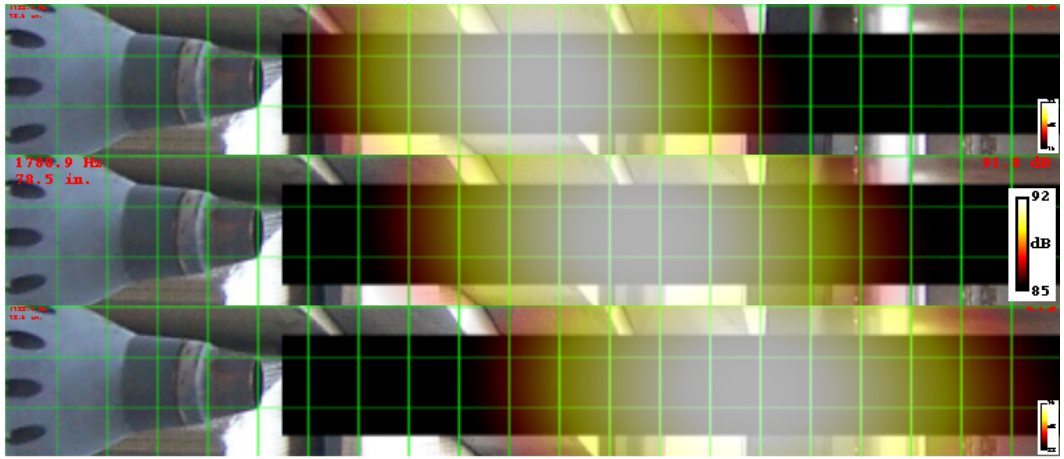

Mj=0.55 Hot
Mj=0.9 Hot
Mj=1.4 Cold
DS Distance (noz diams)
15
10
5
0
10^3
10^4
Freq (Hz)

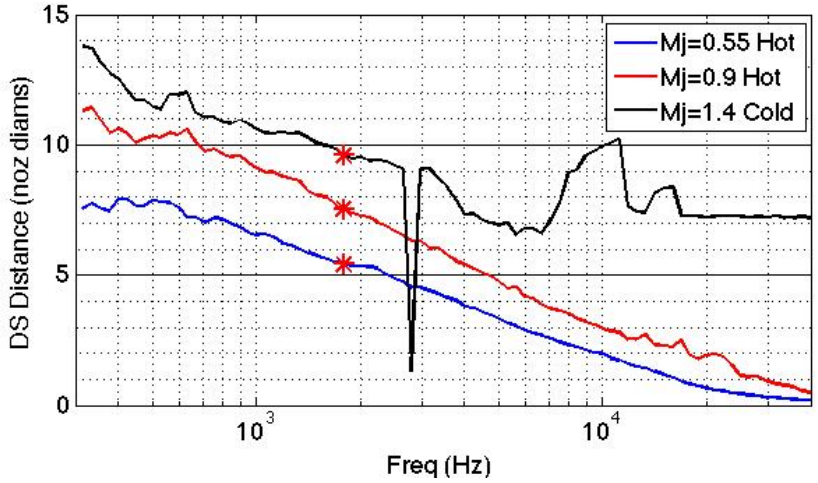

Mj=0.55 Hot
Mj=0.9 Hot
Mj=1.4 Cold
1/12th OB Array Median SPL (dB)
120
110
100
90
80
70
10^3
10^4

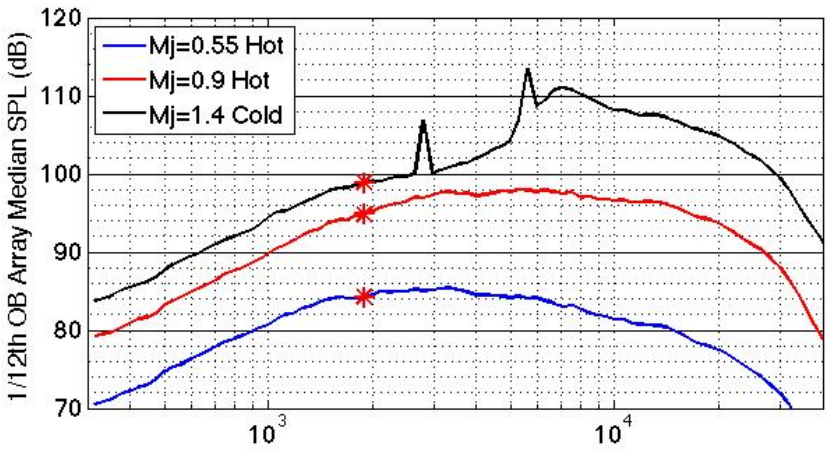

1697.8 Hz
78.5 in.
92
dB
85

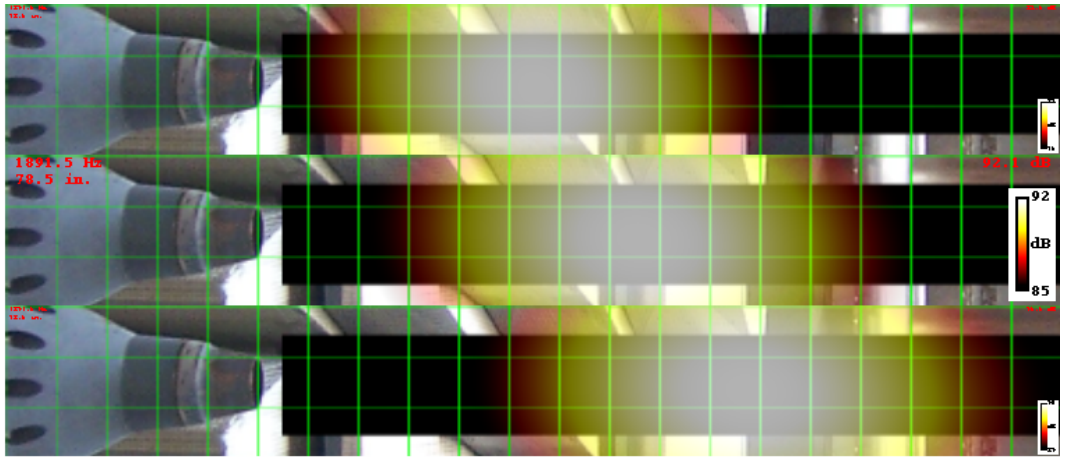

Mj=0.55 Hot
Mj=0.9 Hot
Mj=1.4 Cold
DS Distance (noz diams)
15
10
5
0
10^3
10^4
Freq (Hz)

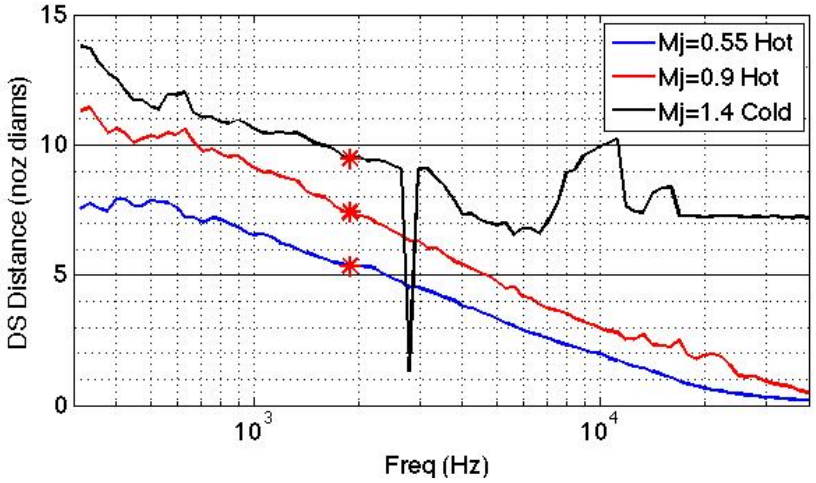

Mj=0.55 Hot
Mj=0.9 Hot
Mj=1.4 Cold
1/12th OB Array Median SPL (dB)
120
110
100
90
80
70
10^3
10^4

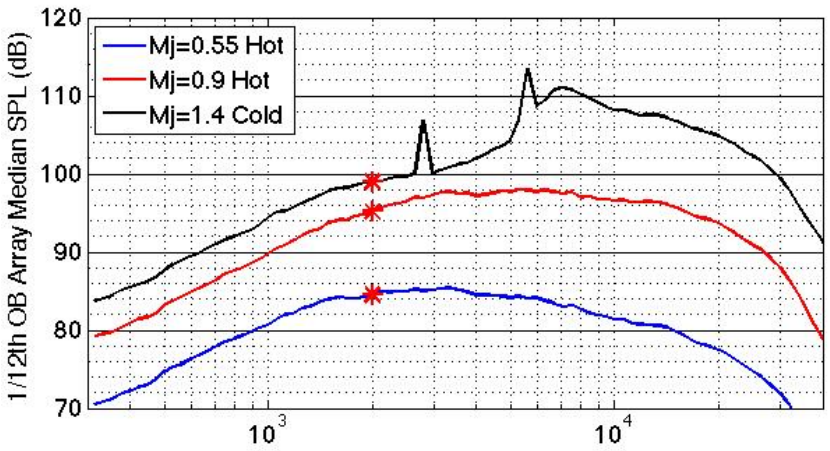

1700.9 Hz
78.5 in.
92
dB
85

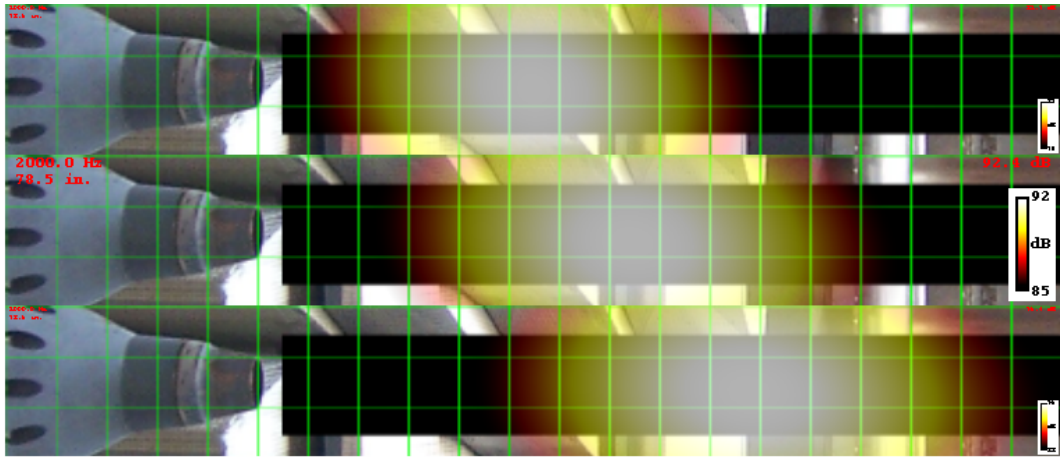

Mj=0.55 Hot
Mj=0.9 Hot
Mj=1.4 Cold
DS Distance (noz diams)
15
10
5
0
10^3
10^4
Freq (Hz)

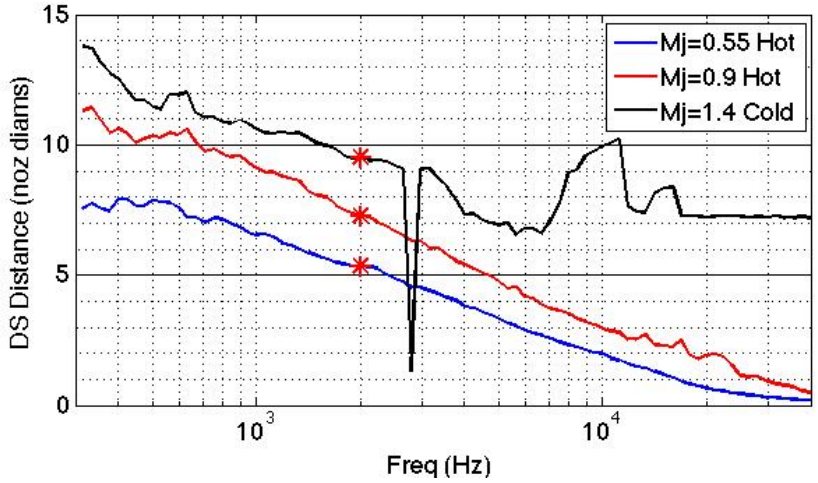

Mj=0.55 Hot
Mj=0.9 Hot
Mj=1.4 Cold
1/12th OB Array Median SPL (dB)
120
110
100
90
80
70
10^3
10^4

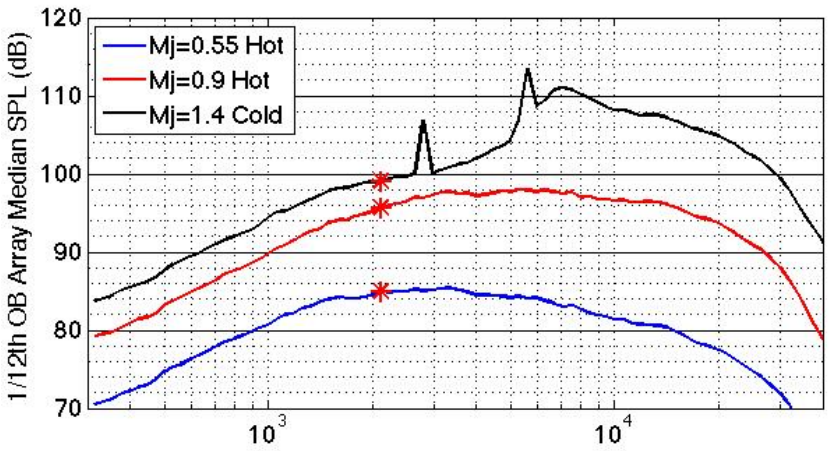

1897.5 Hz
78.5 in.
92
dB
85

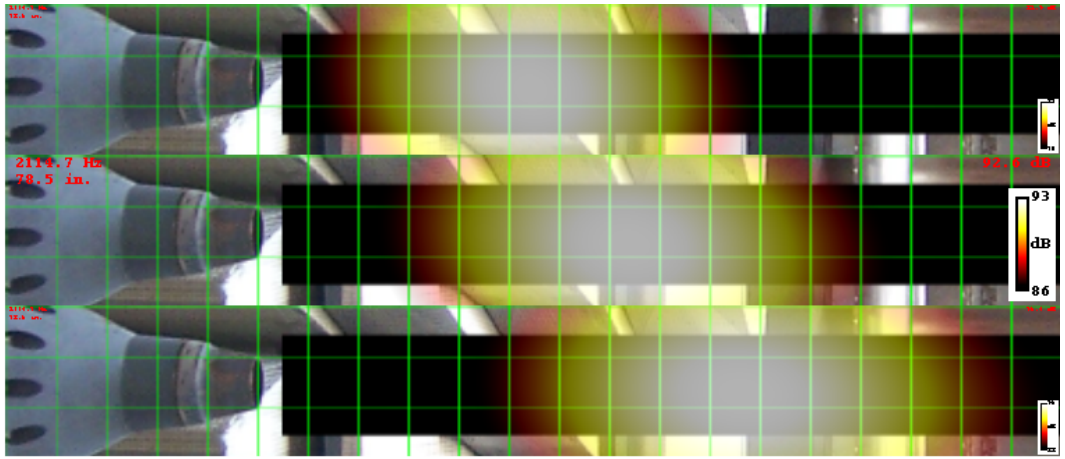

Mj=0.55 Hot
Mj=0.9 Hot
Mj=1.4 Cold
DS Distance (noz diams)
15
10
5
0
10^3
10^4
Freq (Hz)

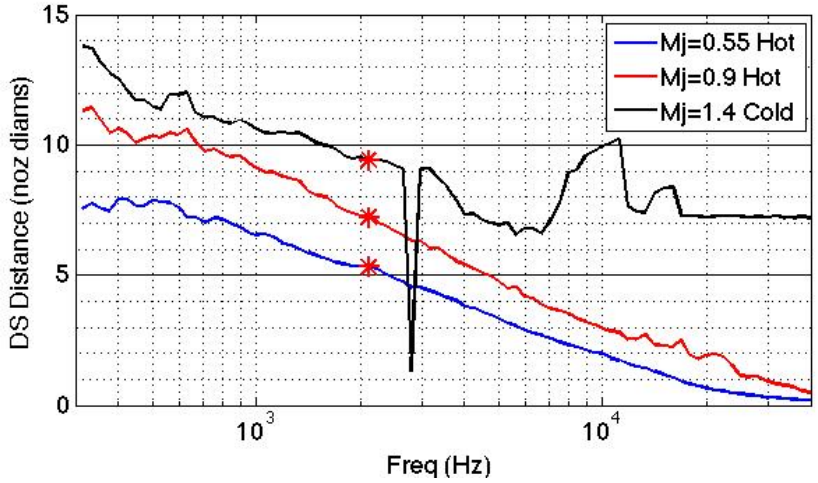

Mj=0.55 Hot
Mj=0.9 Hot
Mj=1.4 Cold
1/12th OB Array Median SPL (dB)
120
110
100
90
80
70
10^3
10^4

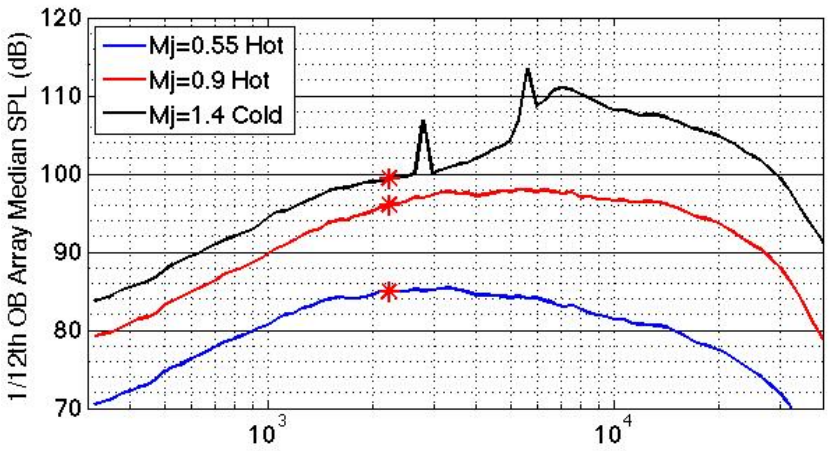

2000.0 Hz
78.5 in.
92
dB
85

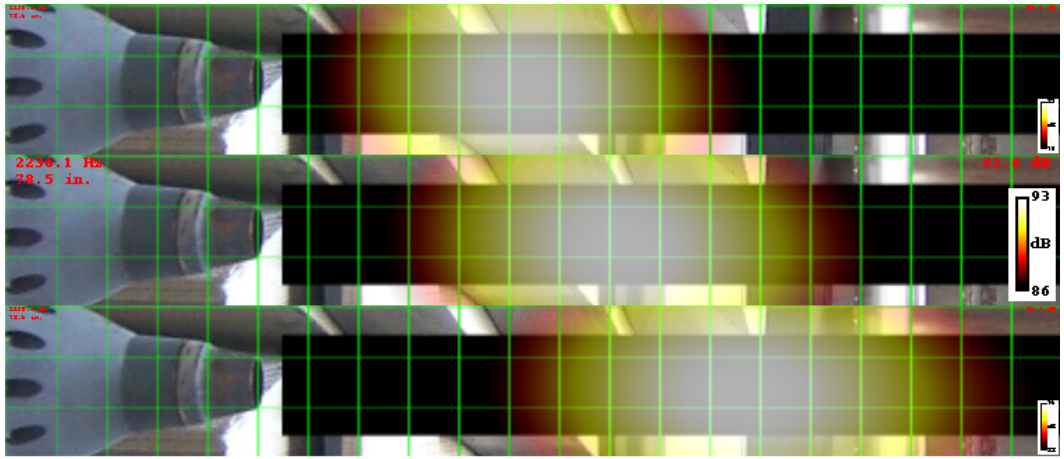

Mj=0.55 Hot
Mj=0.9 Hot
Mj=1.4 Cold
DS Distance (noz diams)
15
10
5
0
10^3
10^4
Freq (Hz)

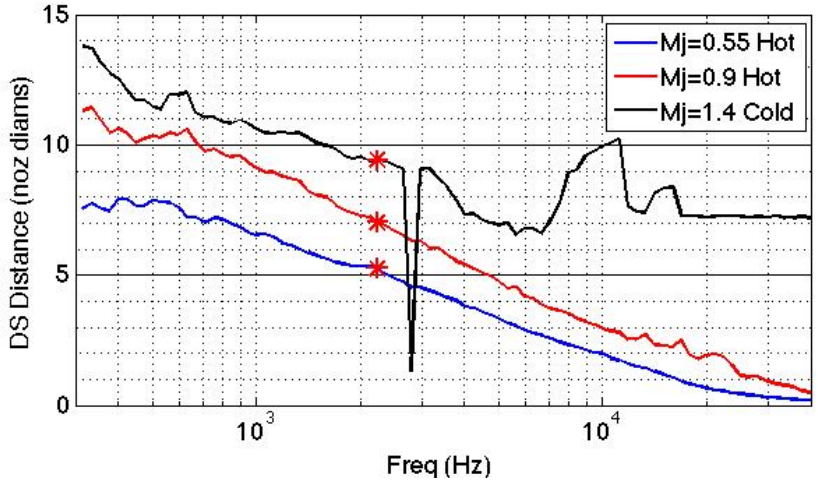

Mj=0.55 Hot
Mj=0.9 Hot
Mj=1.4 Cold
1/12th OB Array Median SPL (dB)
120
110
100
90
80
70
10^3
10^4

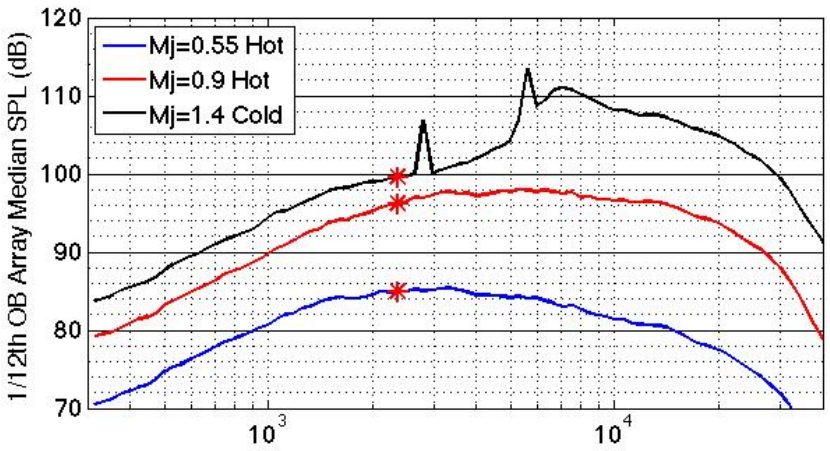

2114.7 Hz
78.5 in.
93
dB
86

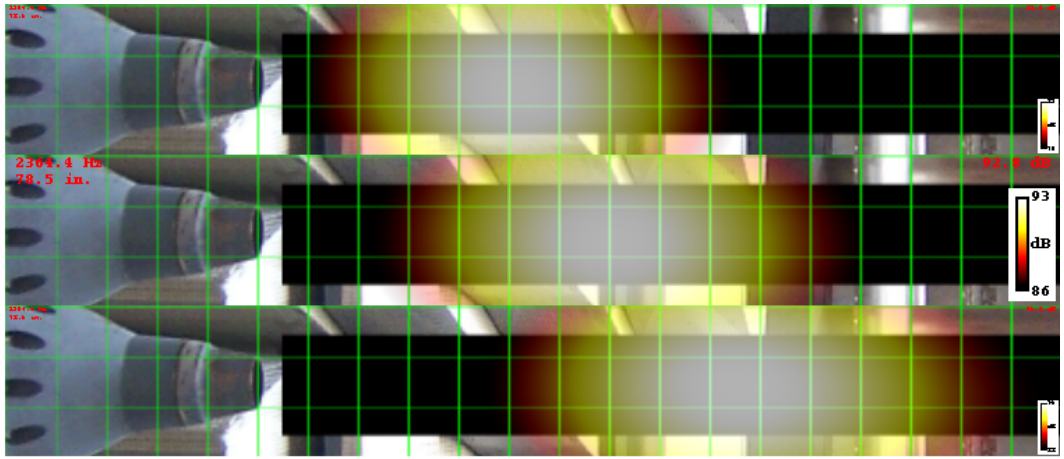

Mj=0.55 Hot
Mj=0.9 Hot
Mj=1.4 Cold
DS Distance (noz diams)
15
10
5
0
10^3
10^4
Freq (Hz)

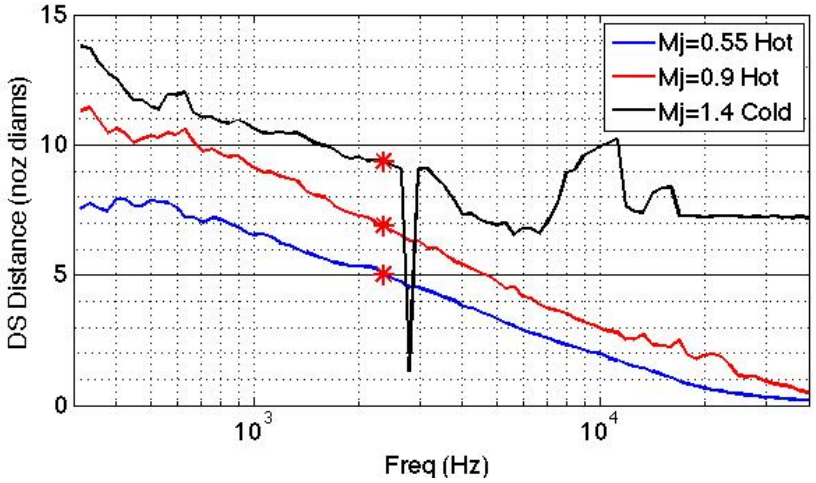

Mj=0.55 Hot
Mj=0.9 Hot
Mj=1.4 Cold
1/12th OB Array Median SPL (dB)
120
110
100
90
80
70
10^3
10^4

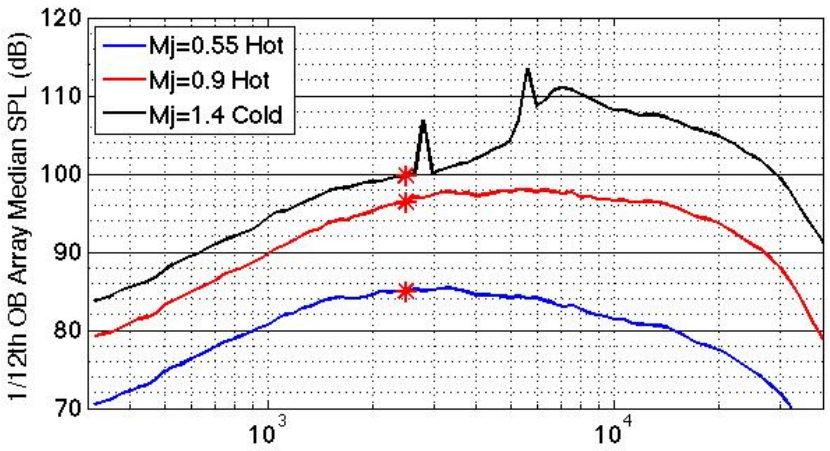

2230.1 Hz
78.5 in.
93
dB
86

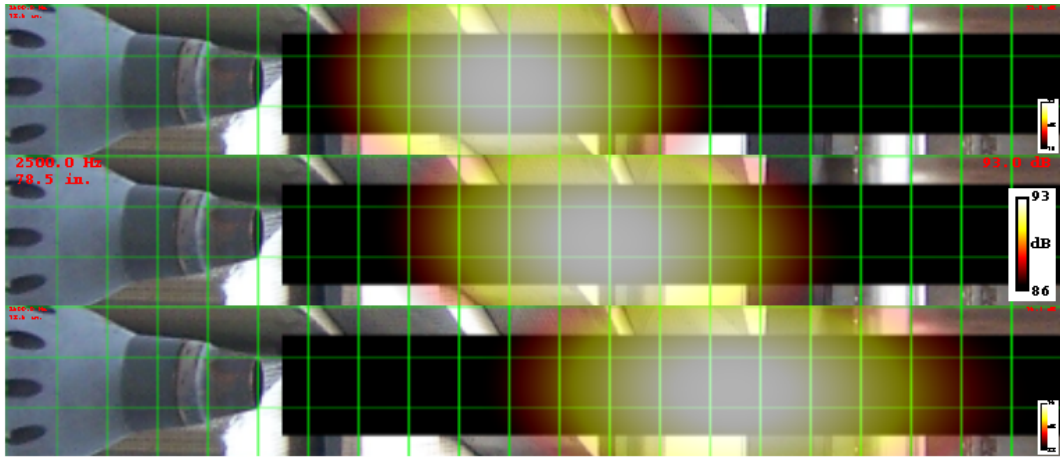

Mj=0.55 Hot
Mj=0.9 Hot
Mj=1.4 Cold
DS Distance (noz diams)
15
10
5
0
10^3
10^4
Freq (Hz)

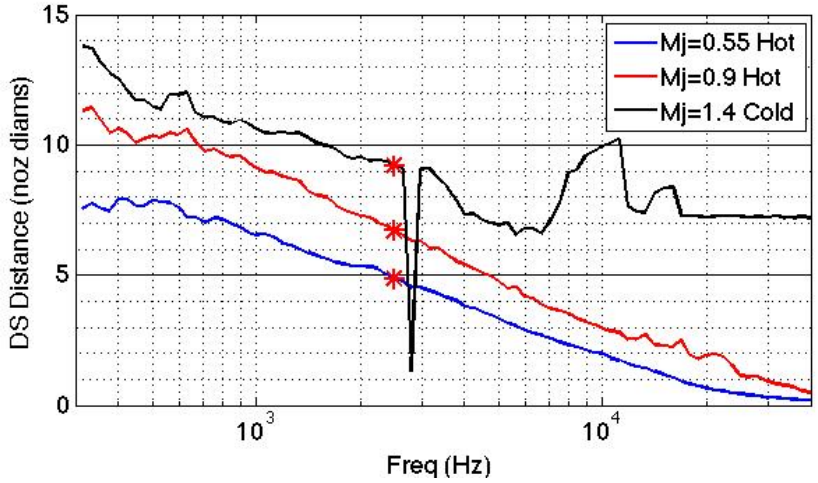

Mj=0.55 Hot
Mj=0.9 Hot
Mj=1.4 Cold
1/12th OB Array Median SPL (dB)
120
110
100
90
80
70
10^3
10^4

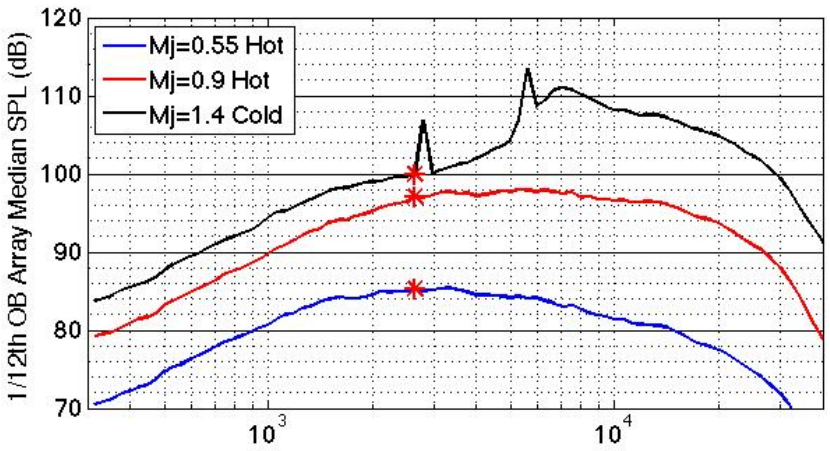

2304.4 Hz
78.5 in.
93
dB
86

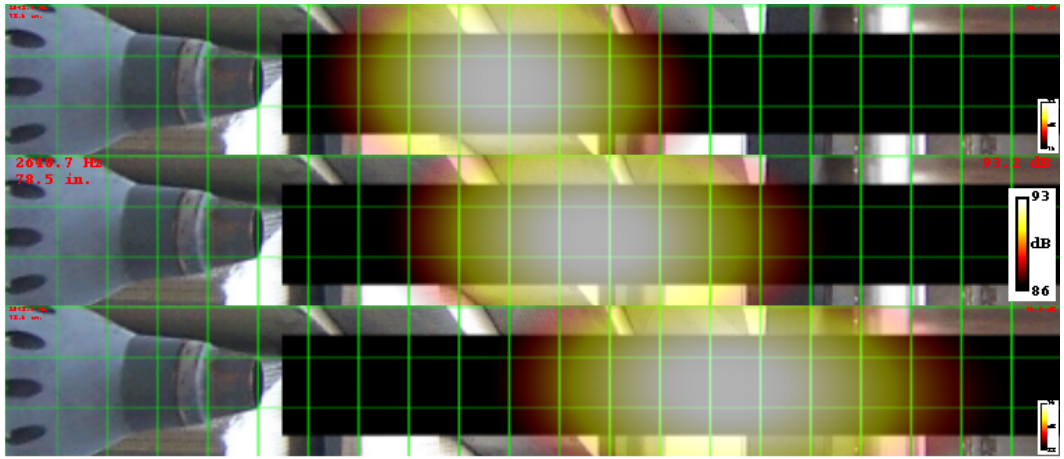

Mj=0.55 Hot
Mj=0.9 Hot
Mj=1.4 Cold
DS Distance (noz diams)
15
10
5
0
10^3
10^4
Freq (Hz)

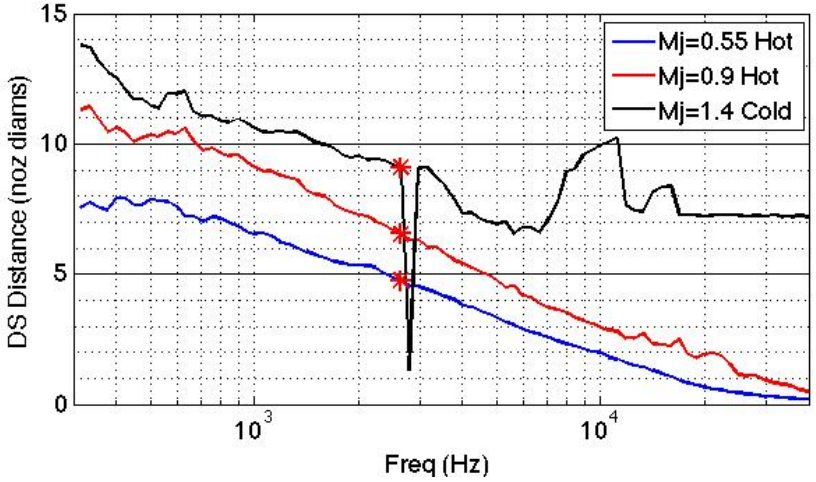

Mj=0.55 Hot
Mj=0.9 Hot
Mj=1.4 Cold
1/12th OB Array Median SPL (dB)
120
110
100
90
80
70
10^3
10^4

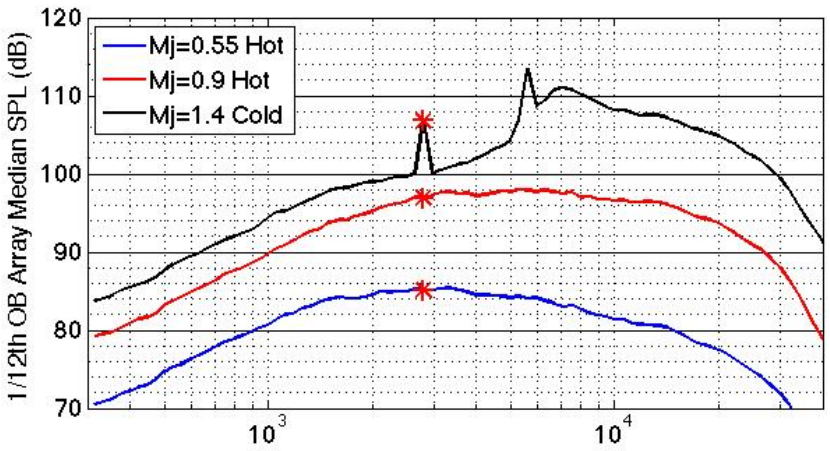

2500.0 Hz
78.5 in.
93
dB
86

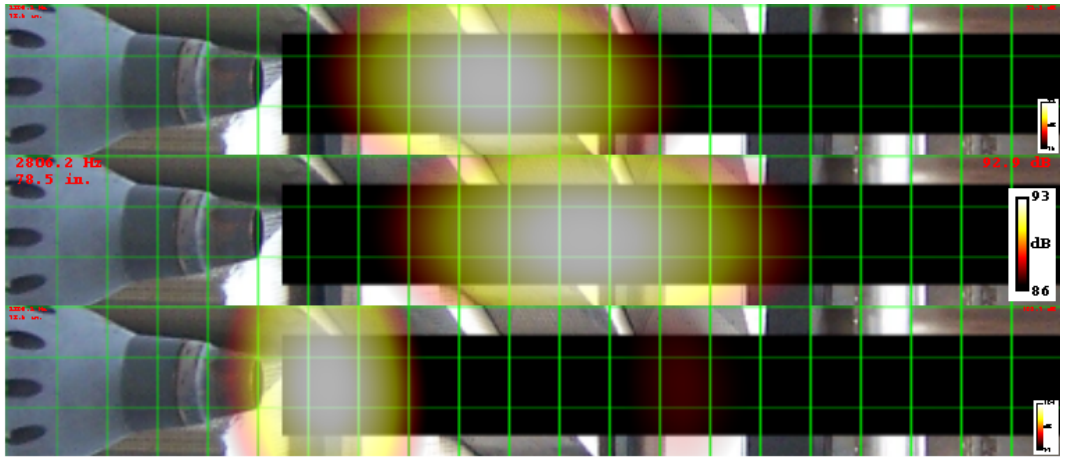

Mj=0.55 Hot
Mj=0.9 Hot
Mj=1.4 Cold
DS Distance (noz diams)
15
10
5
0
10^3
10^4
Freq (Hz)

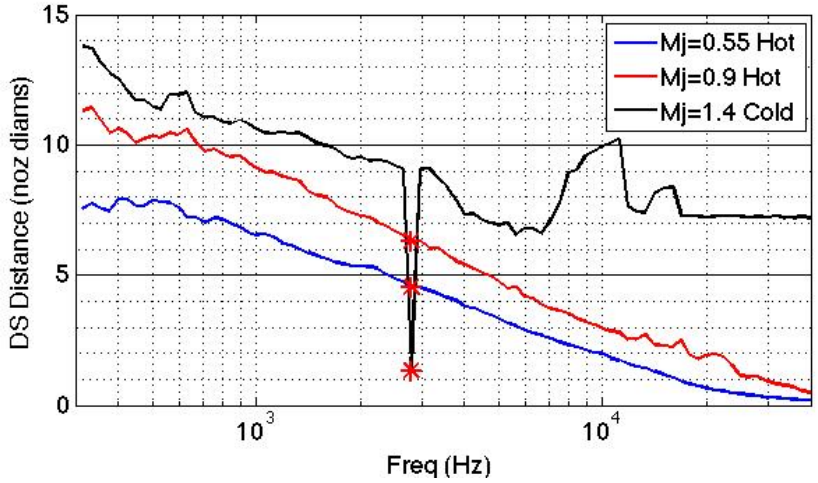

Mj=0.55 Hot
Mj=0.9 Hot
Mj=1.4 Cold
1/12th OB Array Median SPL (dB)
120
110
100
90
80
70
10^3
10^4

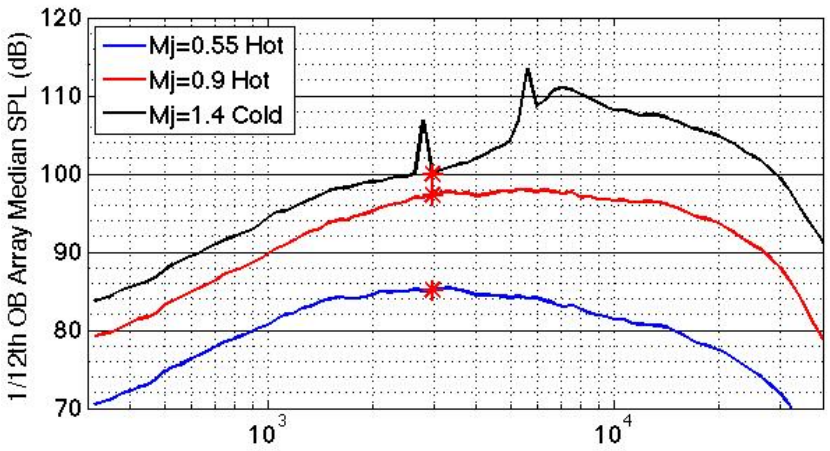

2010.7 Hz
78.5 in.
93
dB
86

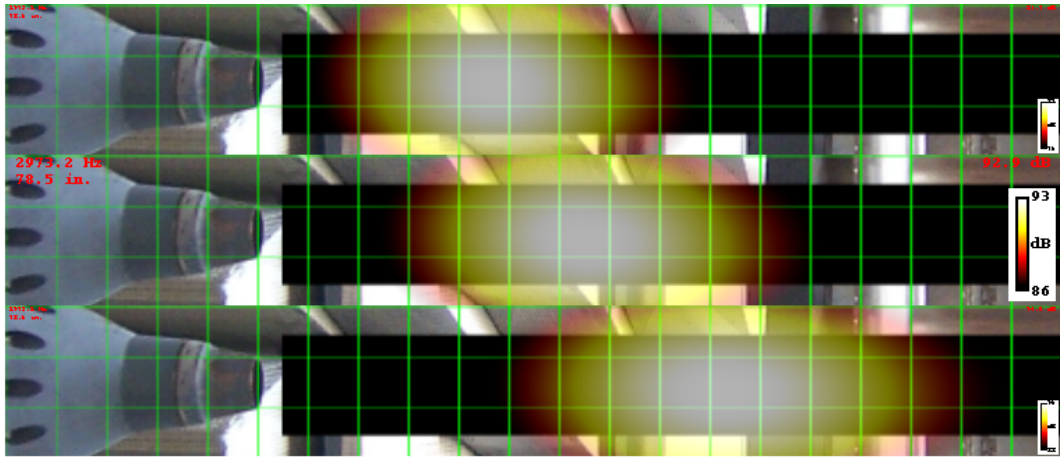

Mj=0.55 Hot
Mj=0.9 Hot
Mj=1.4 Cold
DS Distance (noz diams)
15
10
5
0
10^3
10^4
Freq (Hz)

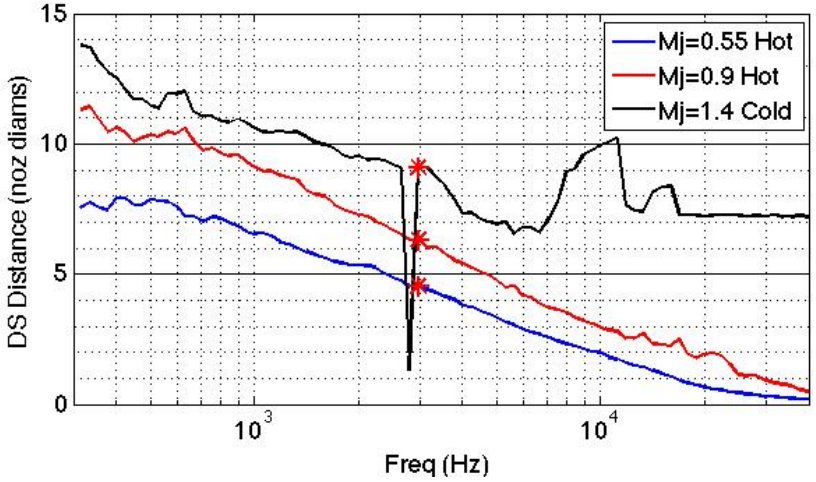

Mj=0.55 Hot
Mj=0.9 Hot
Mj=1.4 Cold
1/12th OB Array Median SPL (dB)
120
110
100
90
80
70
10^3
10^4

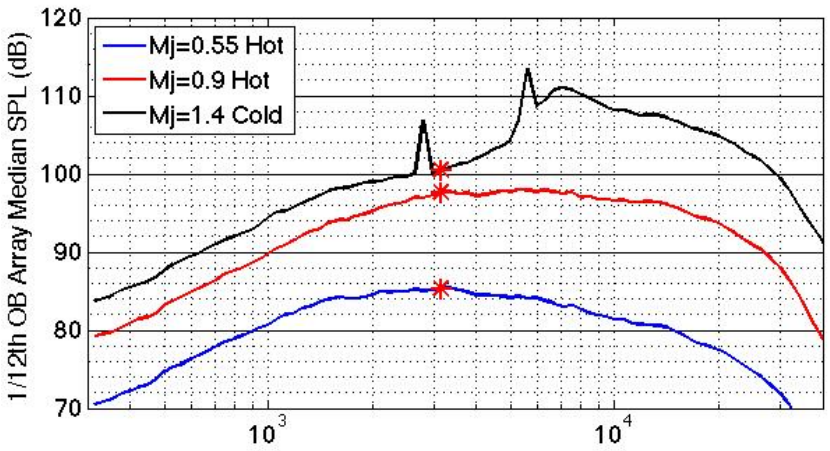

2800.2 Hz
78.5 in.
93
dB
86

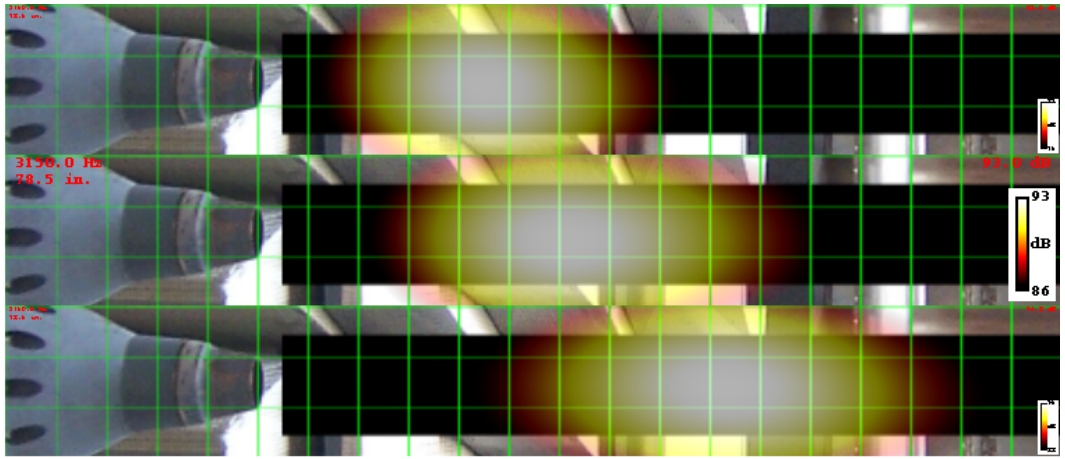

Mj=0.55 Hot
Mj=0.9 Hot
Mj=1.4 Cold
DS Distance (noz diams)
15
10
5
0
10^3
10^4
Freq (Hz)

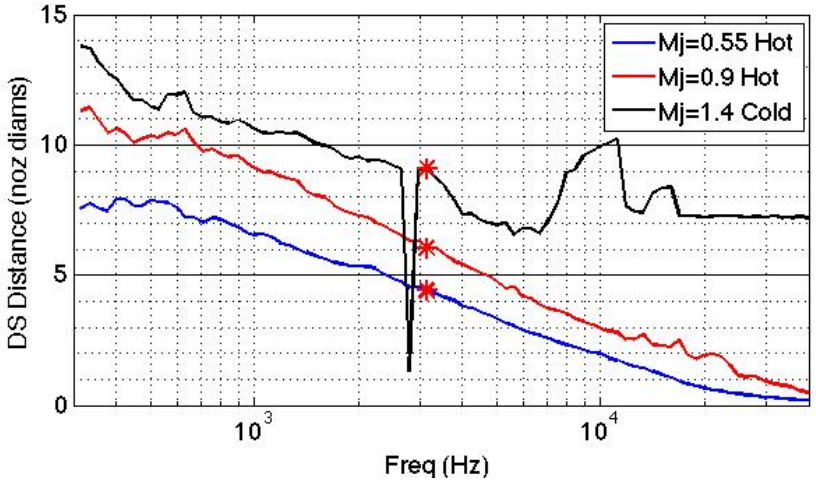

Mj=0.55 Hot
Mj=0.9 Hot
Mj=1.4 Cold
1/12th OB Array Median SPL (dB)
120
110
100
90
80
70
10^3
10^4

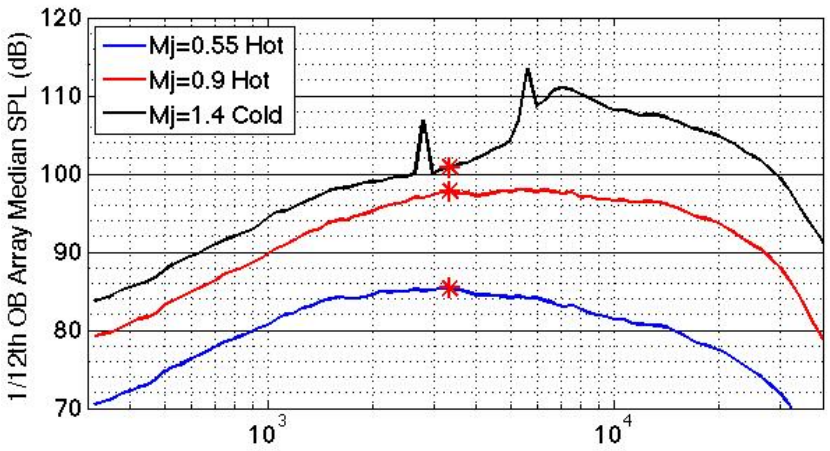

2975.2 Hz
78.5 in.
93
dB
86

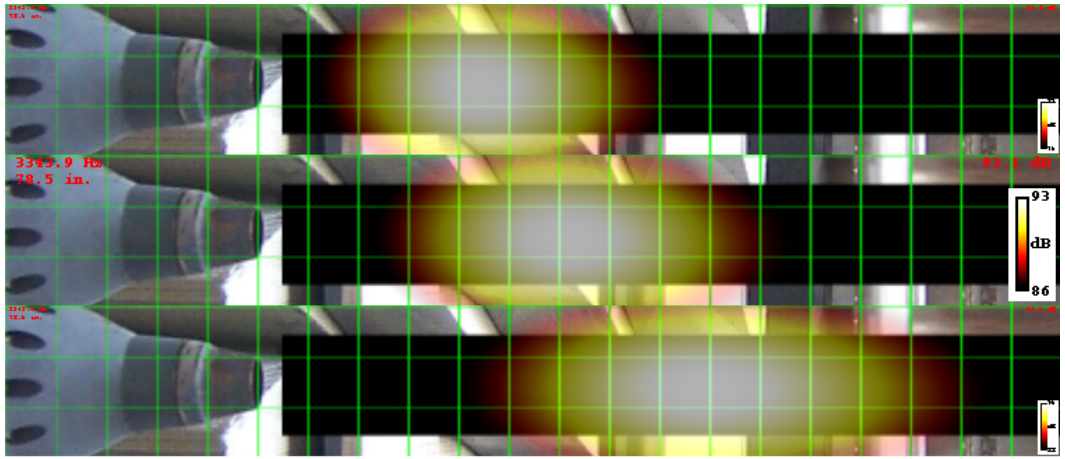

Mj=0.55 Hot
Mj=0.9 Hot
Mj=1.4 Cold
DS Distance (noz diams)
15
10
5
0
10^3
10^4
Freq (Hz)

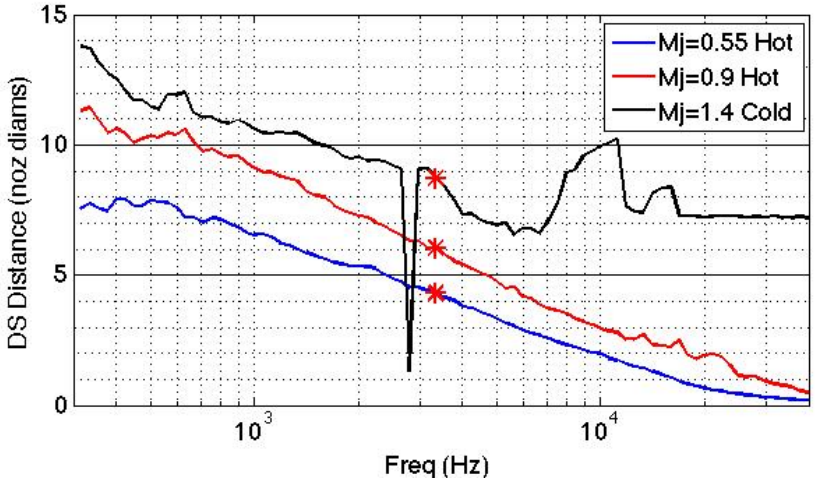

Mj=0.55 Hot
Mj=0.9 Hot
Mj=1.4 Cold
1/12th OB Array Median SPL (dB)
120
110
100
90
80
70
10^3
10^4

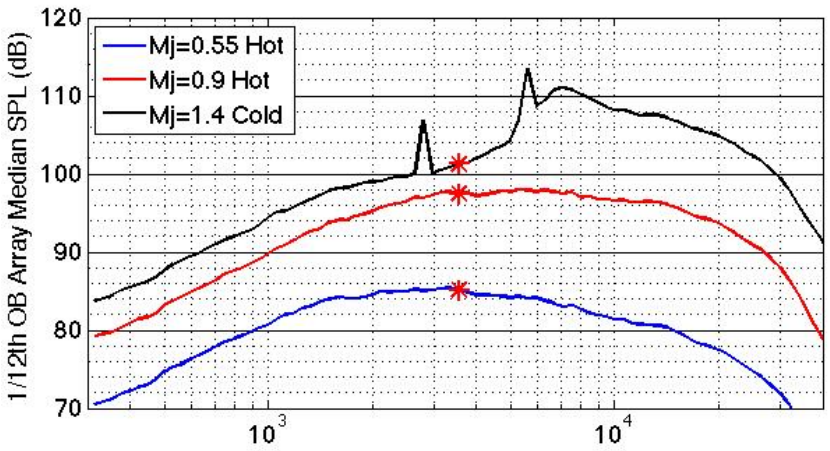

3150.0 Hz
78.5 in.
93
dB
86

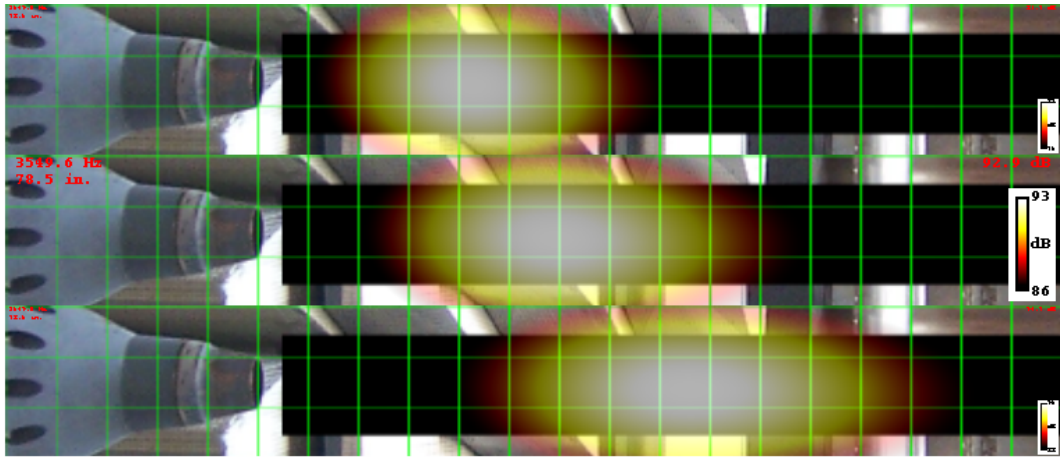

Mj=0.55 Hot
Mj=0.9 Hot
Mj=1.4 Cold
DS Distance (noz diams)
15
10
5
0
10^3
10^4
Freq (Hz)

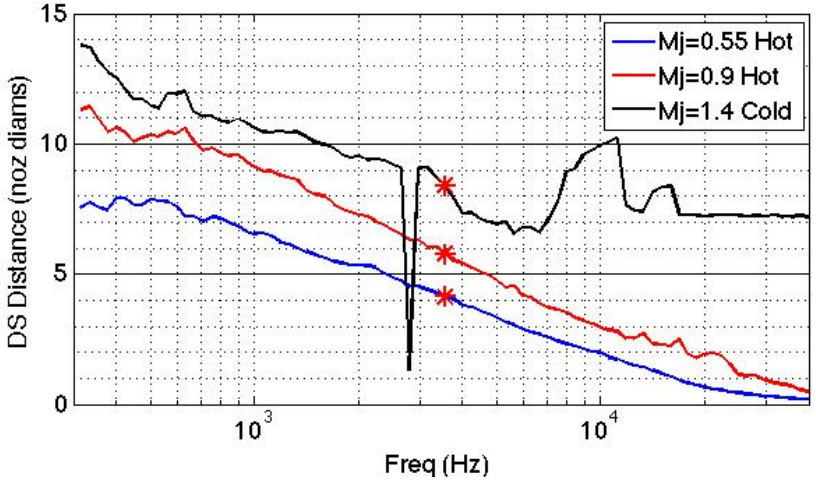

Mj=0.55 Hot
Mj=0.9 Hot
Mj=1.4 Cold
1/12th OB Array Median SPL (dB)
120
110
100
90
80
70
10^3
10^4

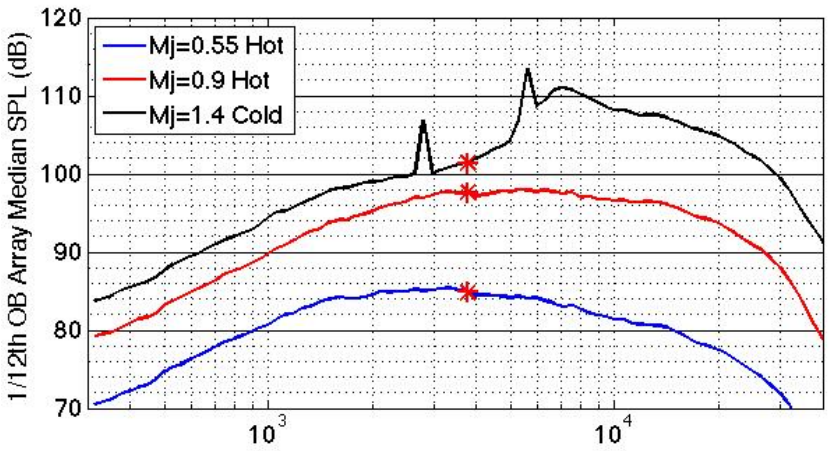

3383.9 Hz
78.5 in.
93
dB
86

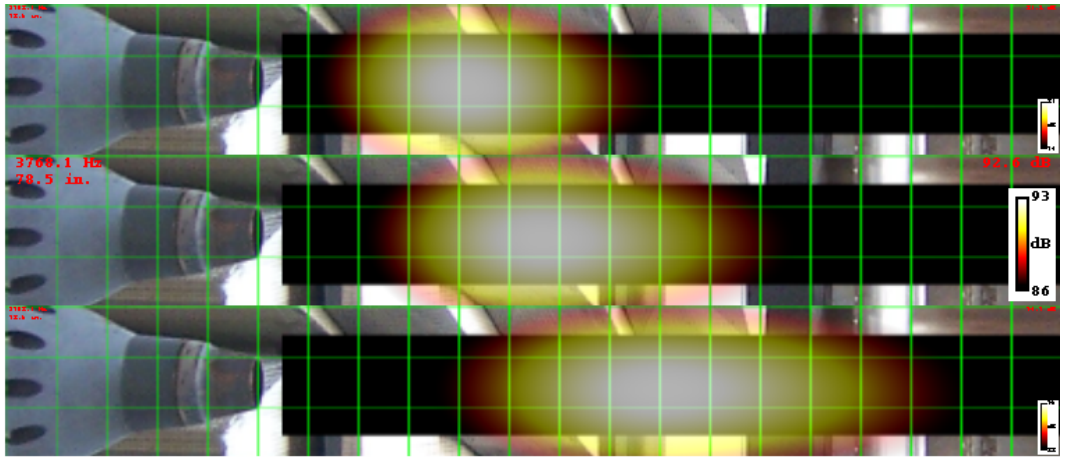

Mj=0.55 Hot
Mj=0.9 Hot
Mj=1.4 Cold
DS Distance (noz diams)
15
10
5
0
10^3
10^4
Freq (Hz)

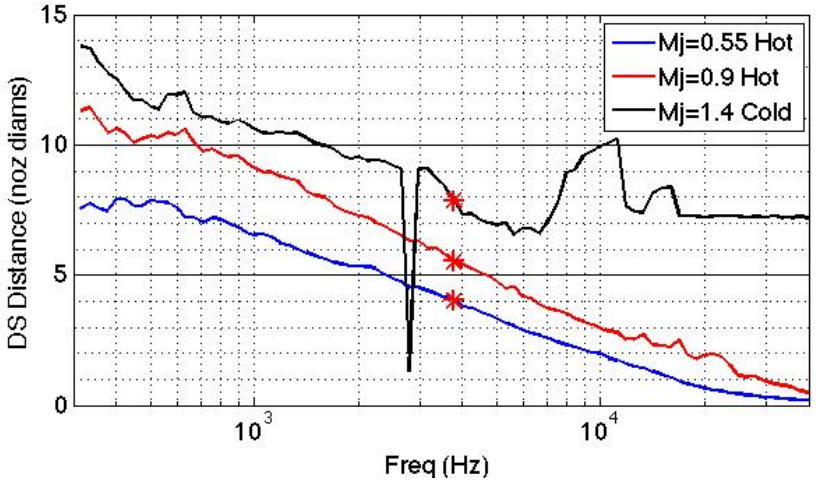

Mj=0.55 Hot
Mj=0.9 Hot
Mj=1.4 Cold
1/12th OB Array Median SPL (dB)
120
110
100
90
80
70
10^3
10^4

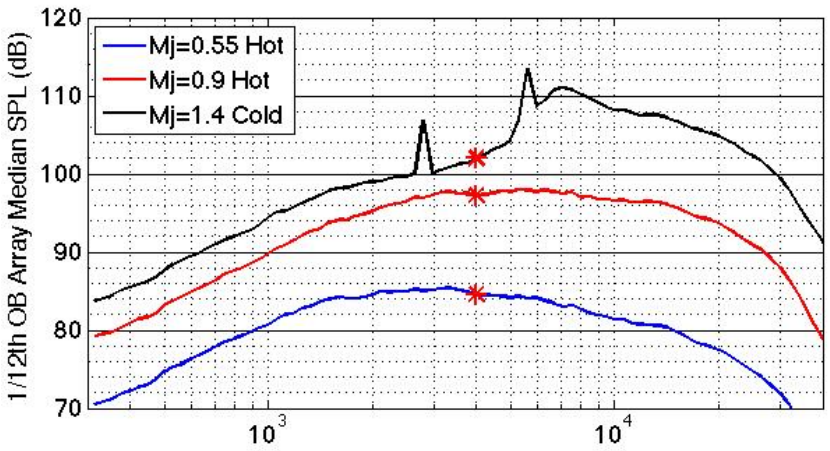

3589.6 Hz
78.5 in.
93
dB
86

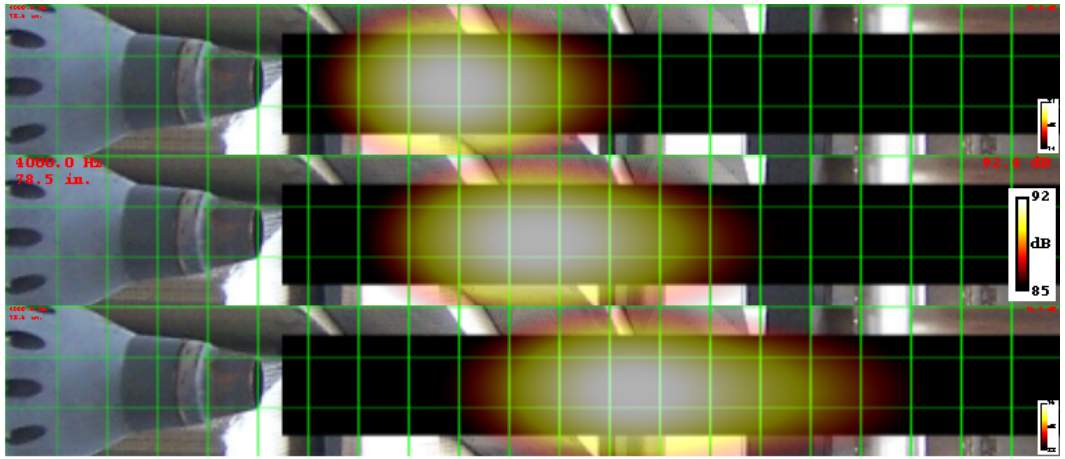

Mj=0.55 Hot
Mj=0.9 Hot
Mj=1.4 Cold
DS Distance (noz diams)
15
10
5
0
10^3
10^4
Freq (Hz)

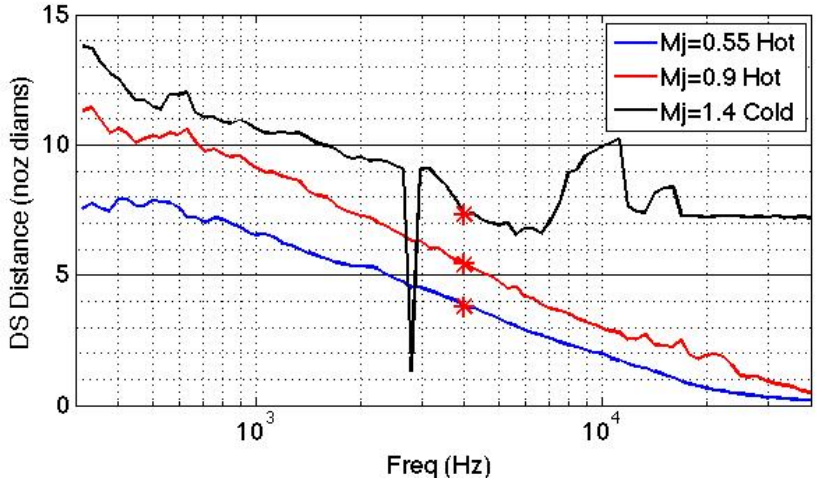

Mj=0.55 Hot
Mj=0.9 Hot
Mj=1.4 Cold
1/12th OB Array Median SPL (dB)
120
110
100
90
80
70
10^3
10^4

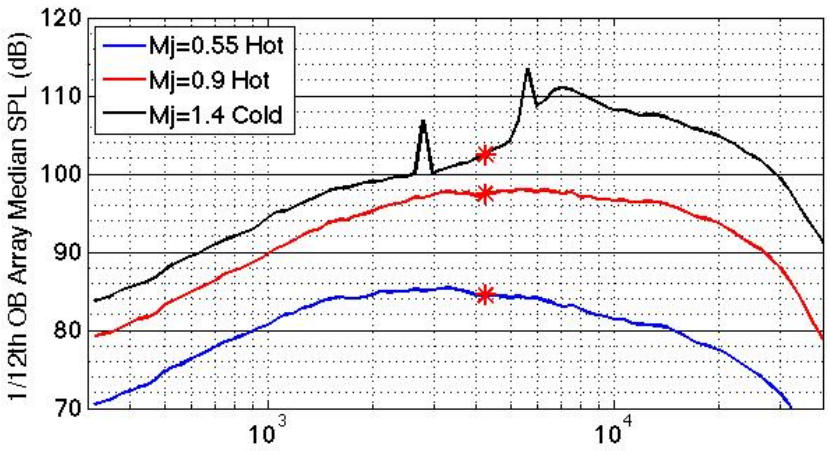

3700.1 Hz
78.5 in.
93
dB
86

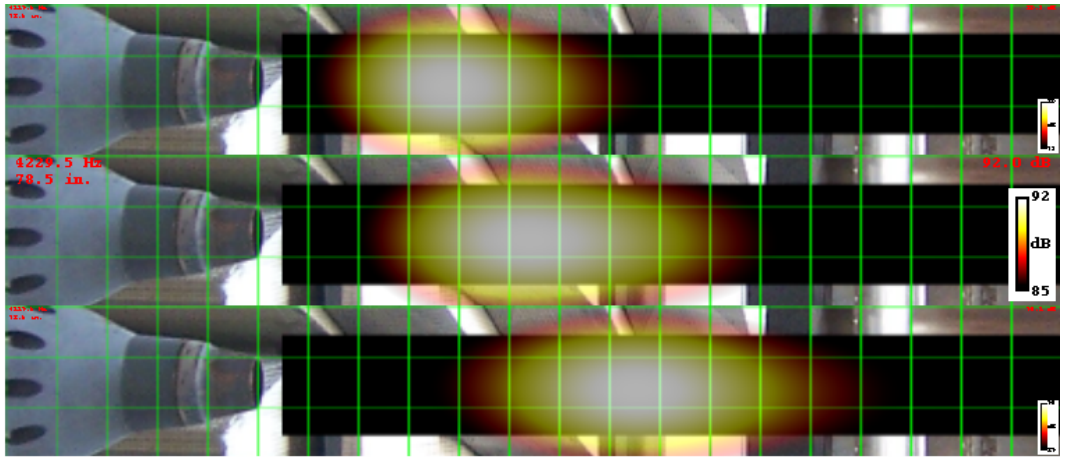

Mj=0.55 Hot
Mj=0.9 Hot
Mj=1.4 Cold
DS Distance (noz diams)
15
10
5
0
10^3
10^4
Freq (Hz)

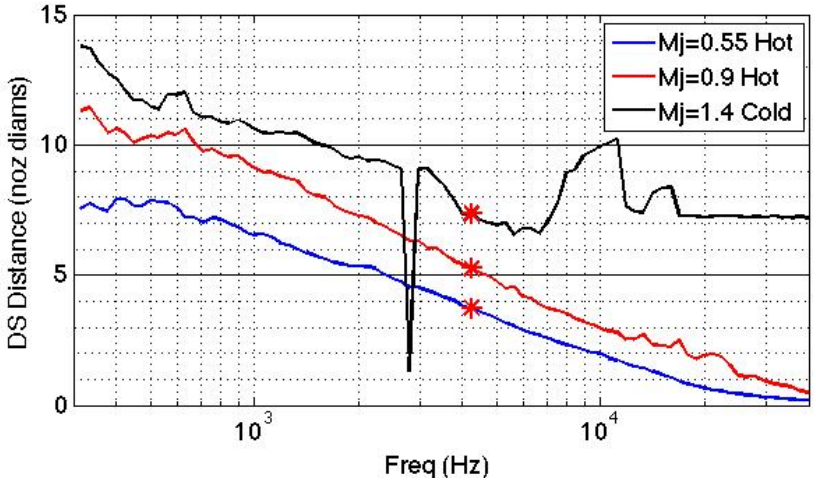

Mj=0.55 Hot
Mj=0.9 Hot
Mj=1.4 Cold
1/12th OB Array Median SPL (dB)
120
110
100
90
80
70
10^3
10^4

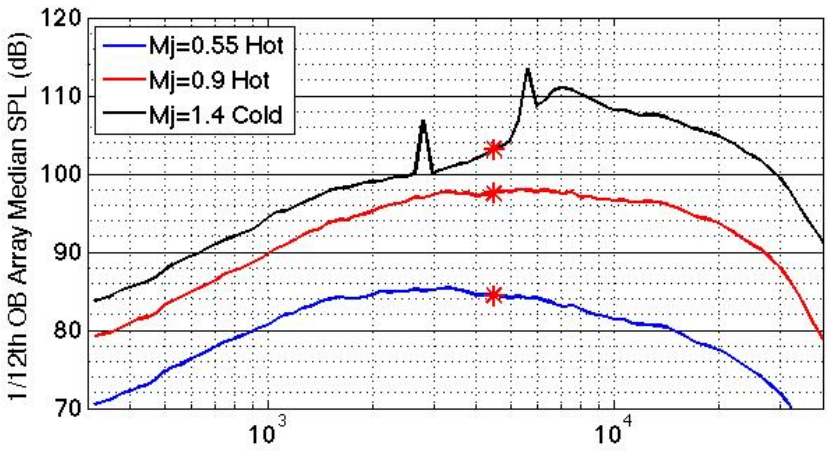

4000.0 Hz
78.5 in.
92
dB
85

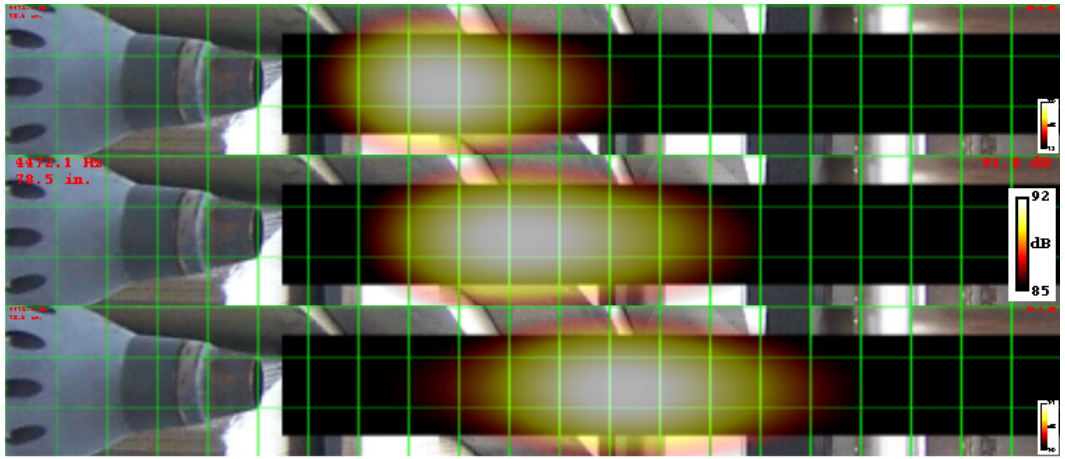

Mj=0.55 Hot
Mj=0.9 Hot
Mj=1.4 Cold
DS Distance (noz diams)
15
10
5
0
10^3
10^4
Freq (Hz)

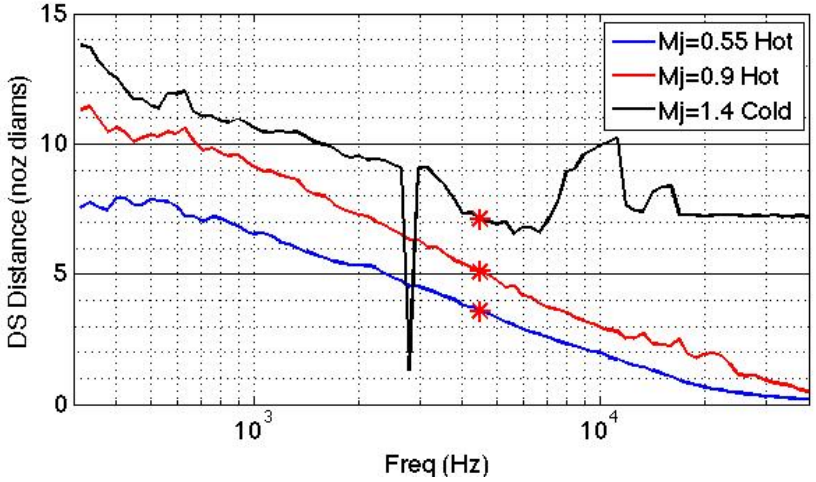

Mj=0.55 Hot
Mj=0.9 Hot
Mj=1.4 Cold
1/12th OB Array Median SPL (dB)
120
110
100
90
80
70
10^3
10^4

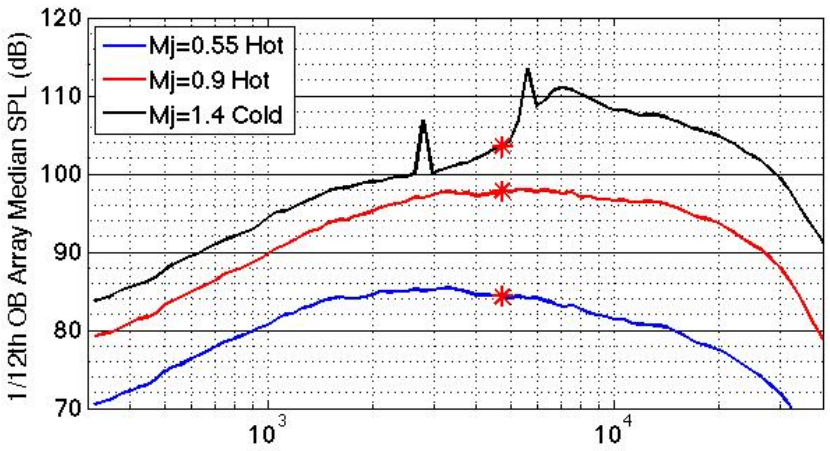

4229.5 Hz
78.5 in.
92
dB
85

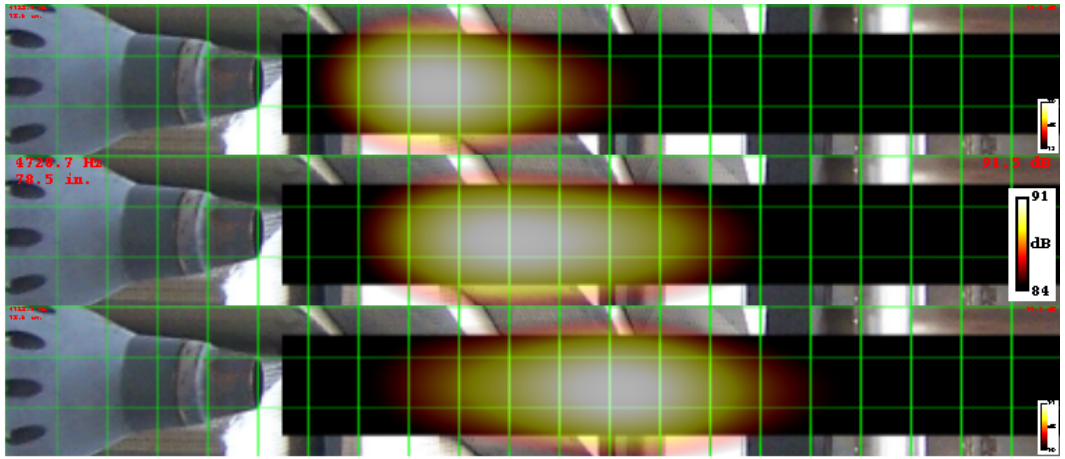

Mj=0.55 Hot
Mj=0.9 Hot
Mj=1.4 Cold
DS Distance (noz diams)
15
10
5
0
10^3
10^4
Freq (Hz)

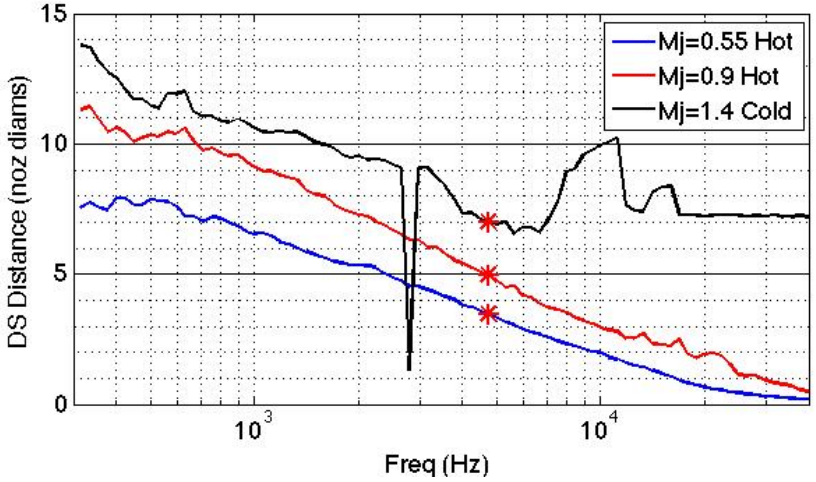

Mj=0.55 Hot
Mj=0.9 Hot
Mj=1.4 Cold
1/12th OB Array Median SPL (dB)
120
110
100
90
80
70
10^3
10^4

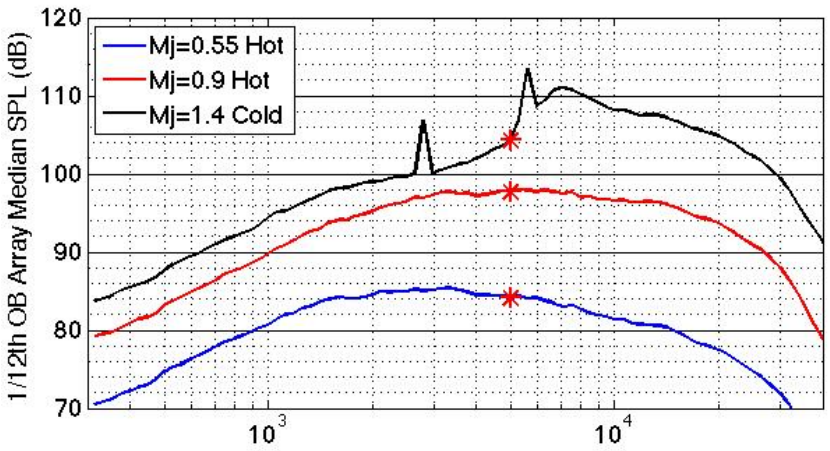

4472.1 Hz
78.5 in.
92
dB
85

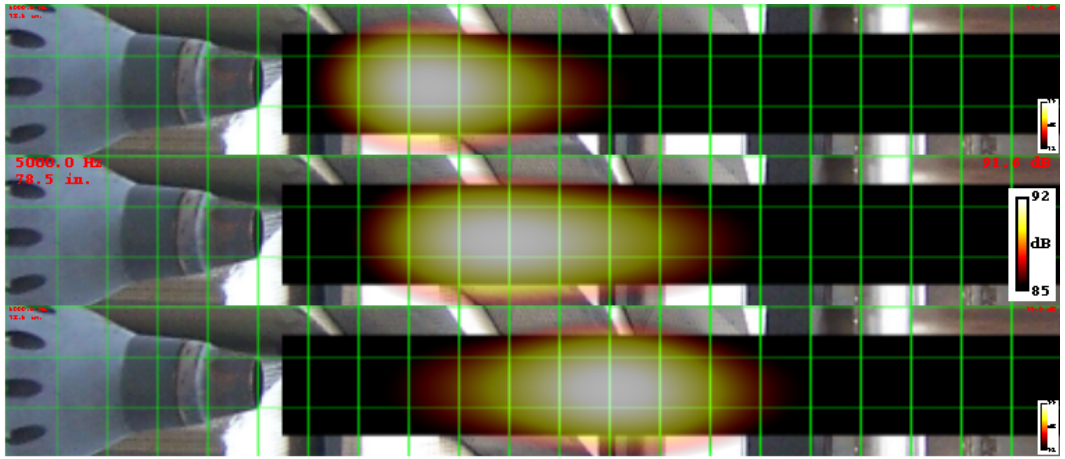

Mj=0.55 Hot
Mj=0.9 Hot
Mj=1.4 Cold
DS Distance (noz diams)
15
10
5
0
10^3
10^4
Freq (Hz)

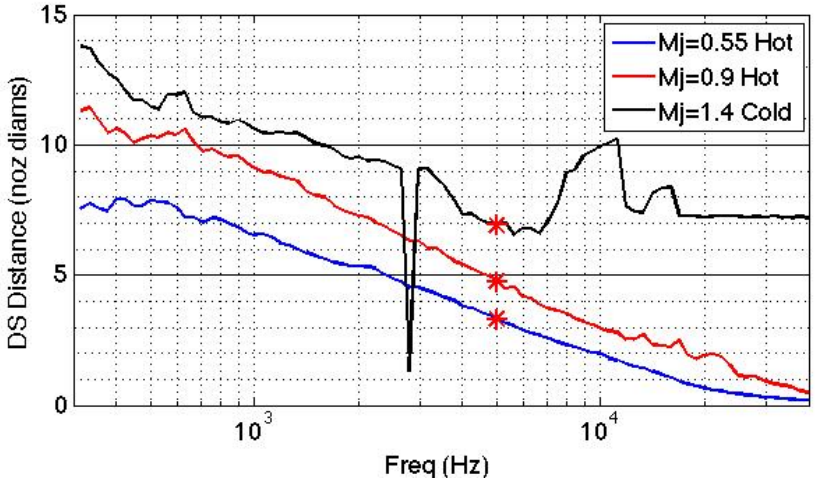

Mj=0.55 Hot
Mj=0.9 Hot
Mj=1.4 Cold
1/12th OB Array Median SPL (dB)
120
110
100
90
80
70
10^3
10^4

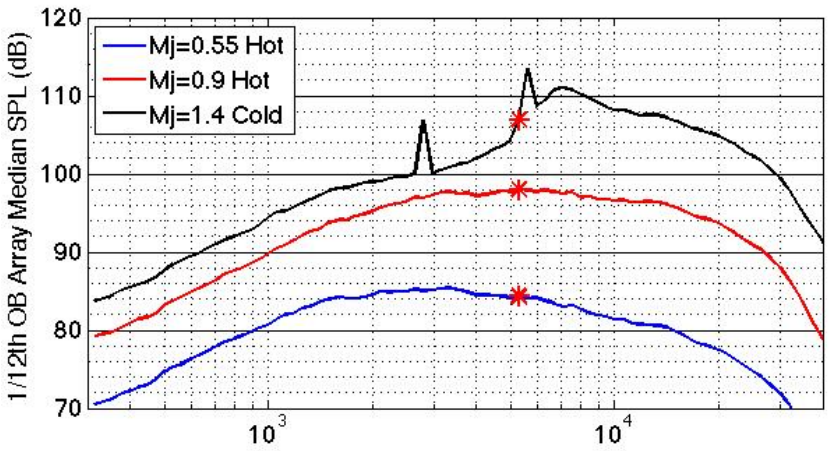

4720.7 Hz
78.5 in.
91
dB
84

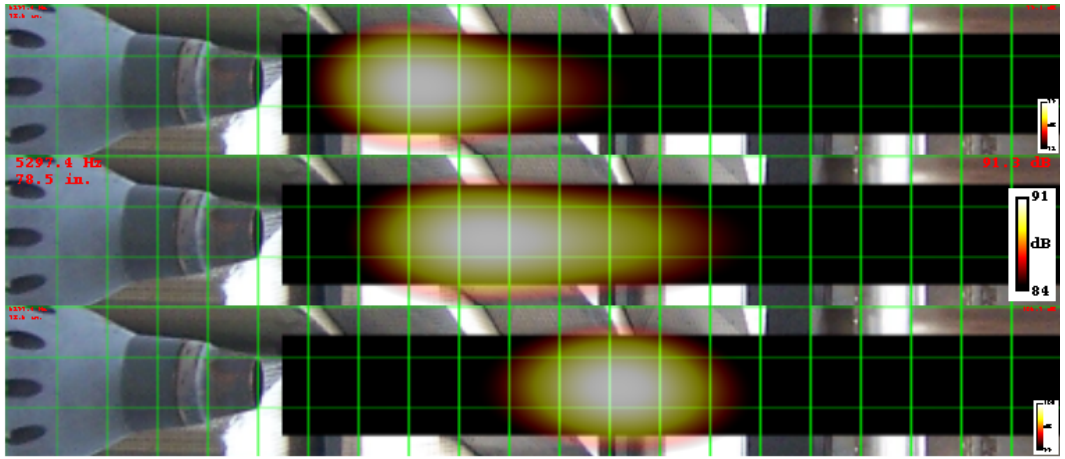

Mj=0.55 Hot
Mj=0.9 Hot
Mj=1.4 Cold
DS Distance (noz diams)
15
10
5
0
10^3
10^4
Freq (Hz)

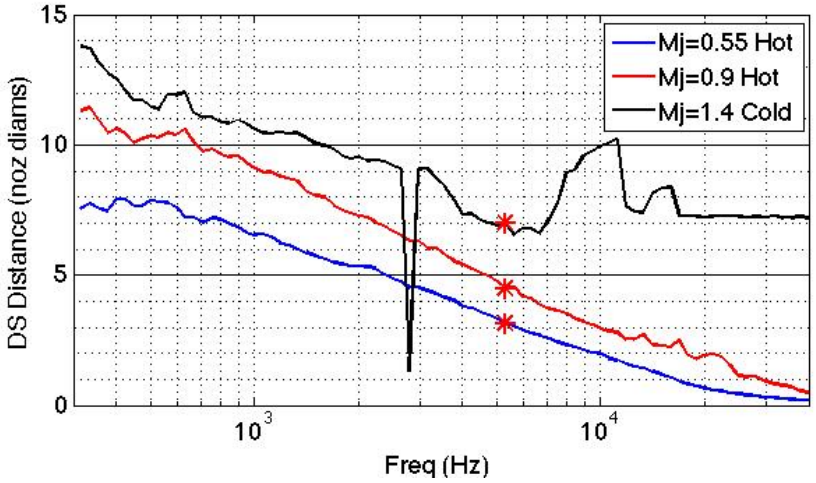

Mj=0.55 Hot
Mj=0.9 Hot
Mj=1.4 Cold
1/12th OB Array Median SPL (dB)
120
110
100
90
80
70
10^3
10^4

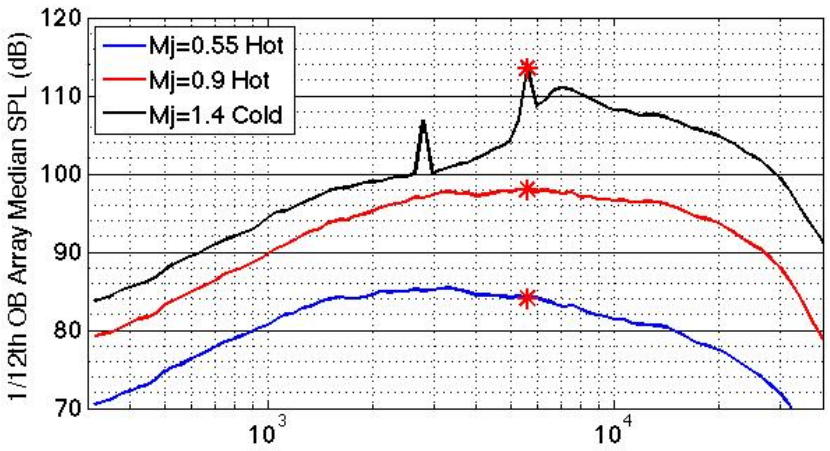

5000.0 Hz
78.5 in.
92
dB
85

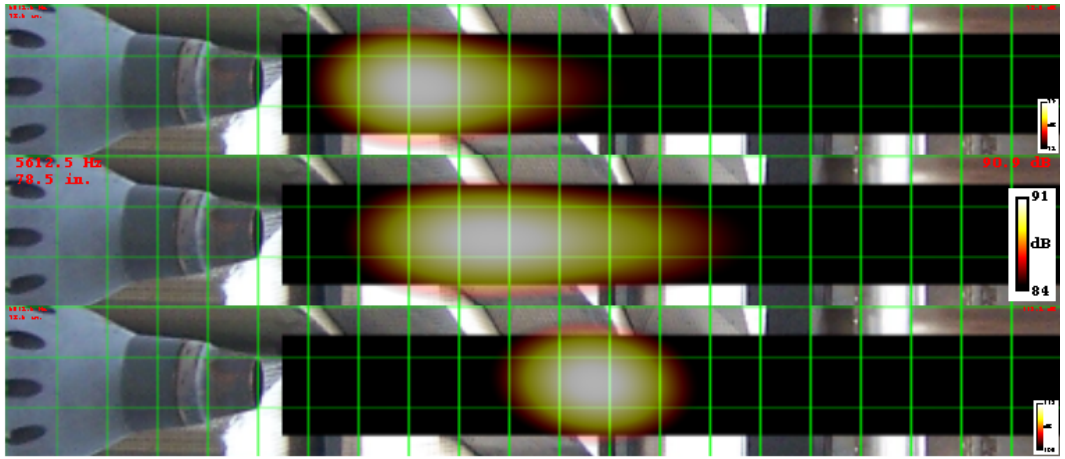

Mj=0.55 Hot
Mj=0.9 Hot
Mj=1.4 Cold
DS Distance (noz diams)
15
10
5
0
10^3
10^4
Freq (Hz)

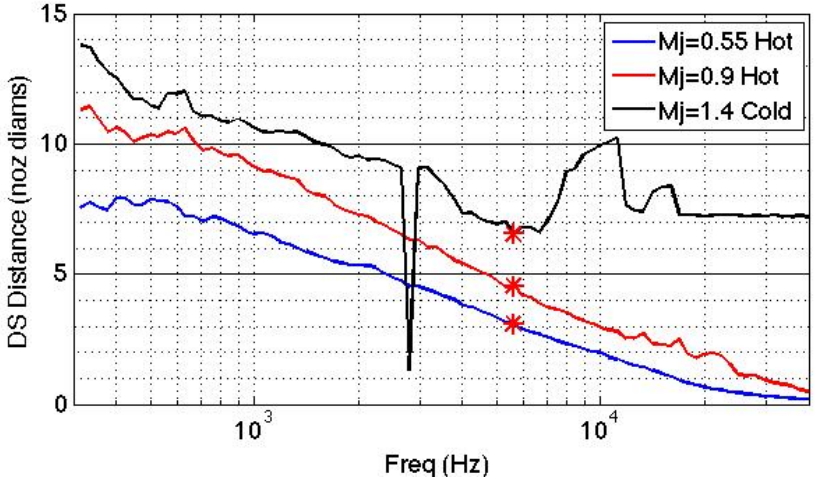

Mj=0.55 Hot
Mj=0.9 Hot
Mj=1.4 Cold
1/12th OB Array Median SPL (dB)
120
110
100
90
80
70
10^3
10^4

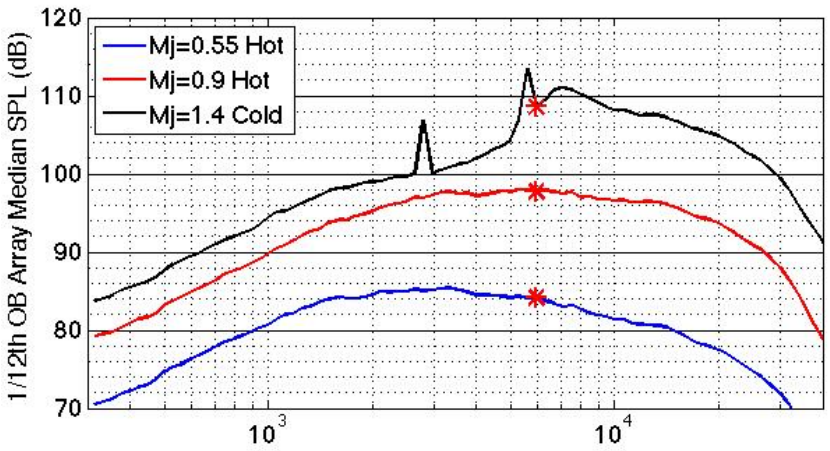

5297.4 Hz
78.5 in.
91
dB
84

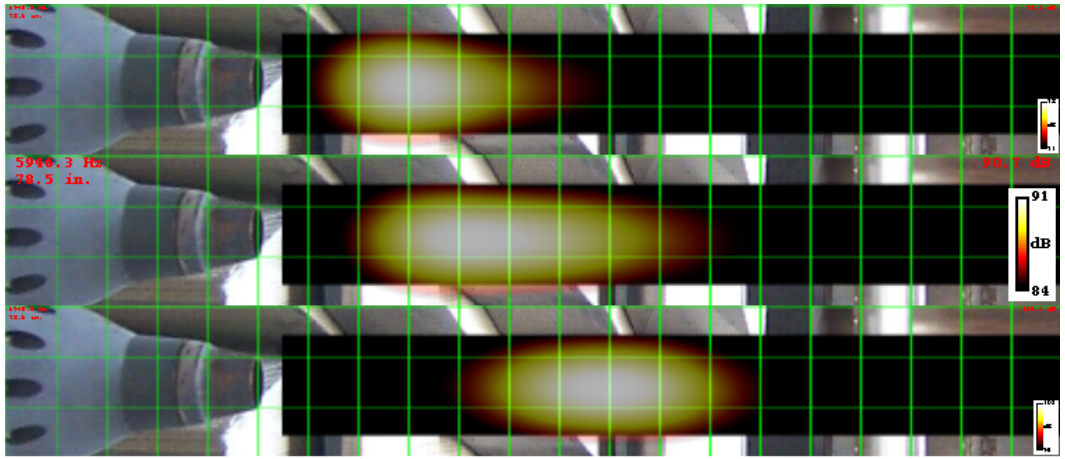

Mj=0.55 Hot
Mj=0.9 Hot
Mj=1.4 Cold
DS Distance (noz diams)
15
10
5
0
10^3
10^4
Freq (Hz)

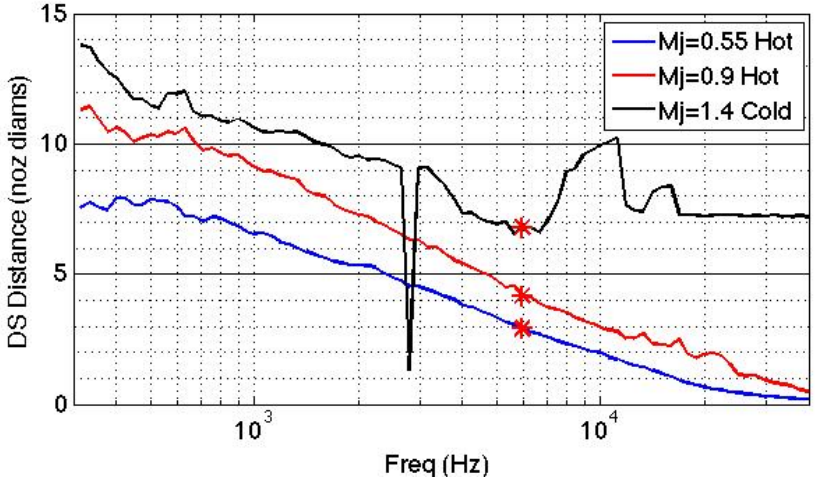

Mj=0.55 Hot
Mj=0.9 Hot
Mj=1.4 Cold
1/12th OB Array Median SPL (dB)
120
110
100
90
80
70
10^3
10^4

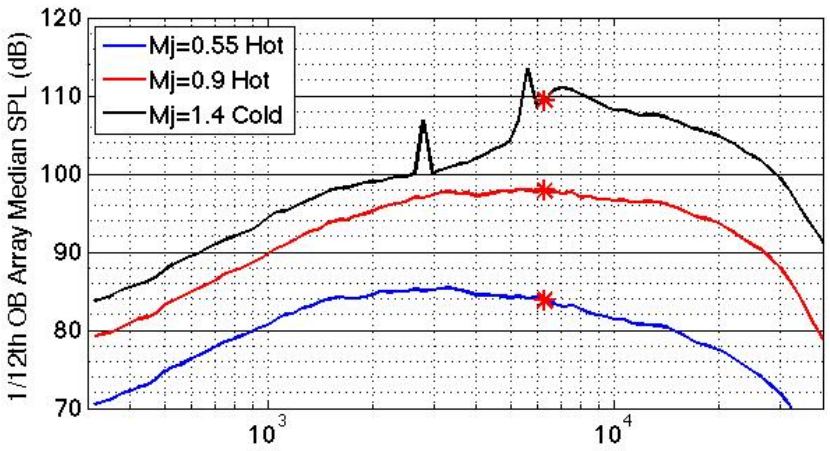

5612.5 Hz
78.5 in.
91
dB
84

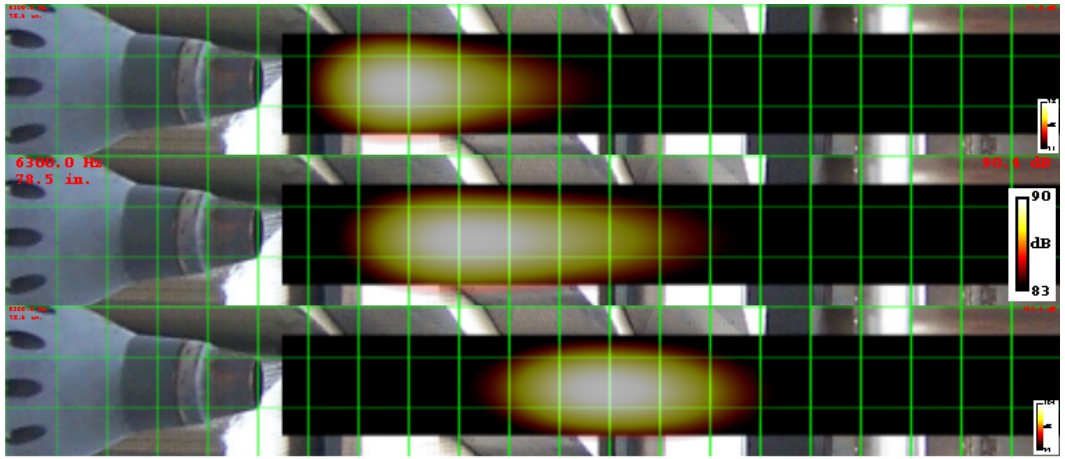

Mj=0.55 Hot
Mj=0.9 Hot
Mj=1.4 Cold
DS Distance (noz diams)
15
10
5
0
10^3
10^4
Freq (Hz)

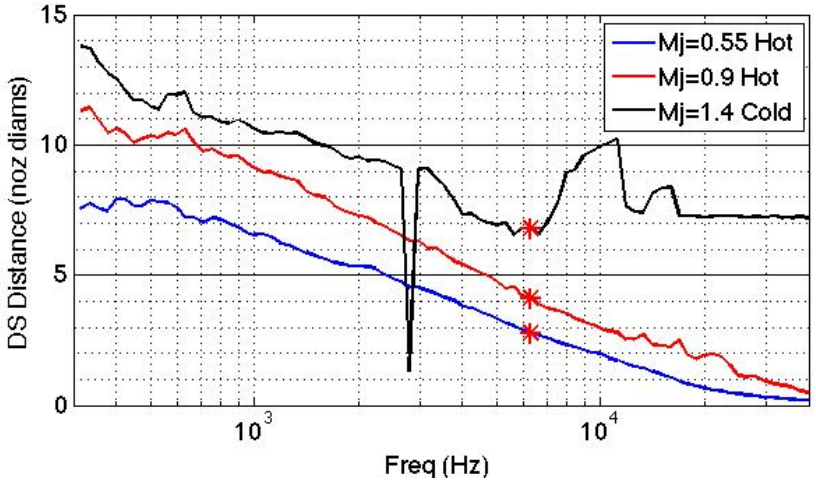

Mj=0.55 Hot
Mj=0.9 Hot
Mj=1.4 Cold
1/12th OB Array Median SPL (dB)
120
110
100
90
80
70
10^3
10^4

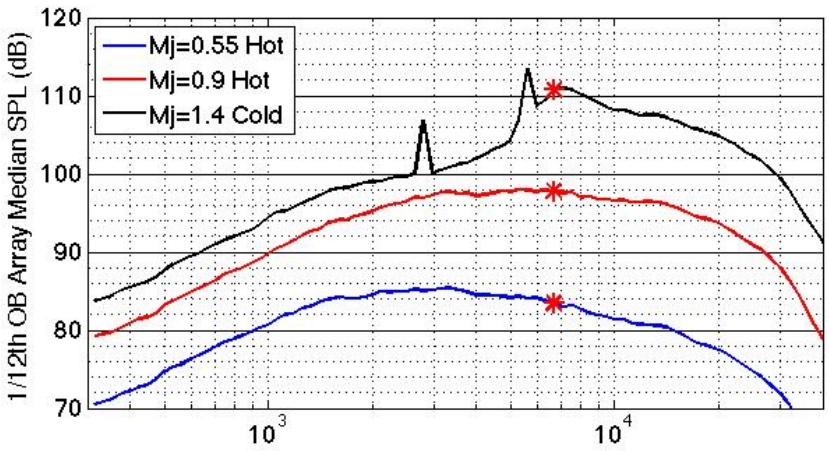

5980.3 Hz
78.5 in.
91
dB
84

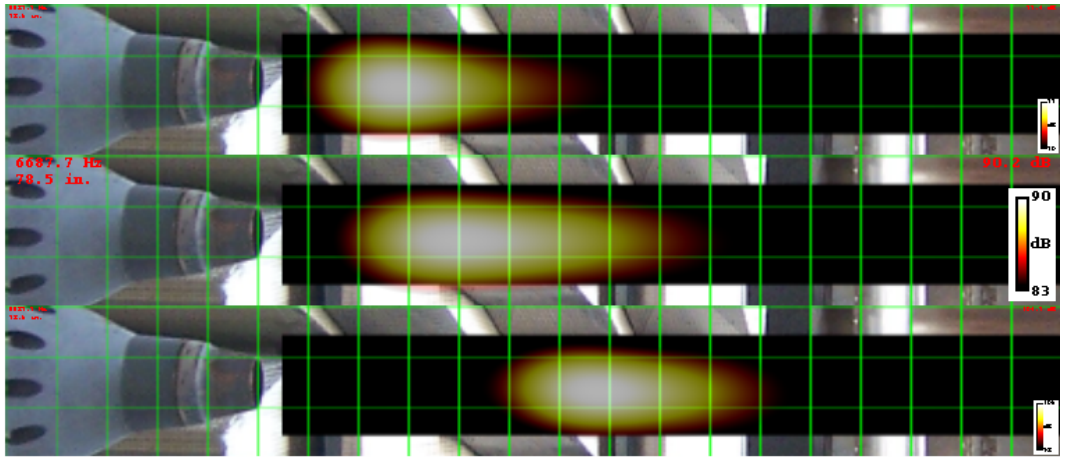

Mj=0.55 Hot
Mj=0.9 Hot
Mj=1.4 Cold
DS Distance (noz diams)
15
10
5
0
10^3
10^4
Freq (Hz)

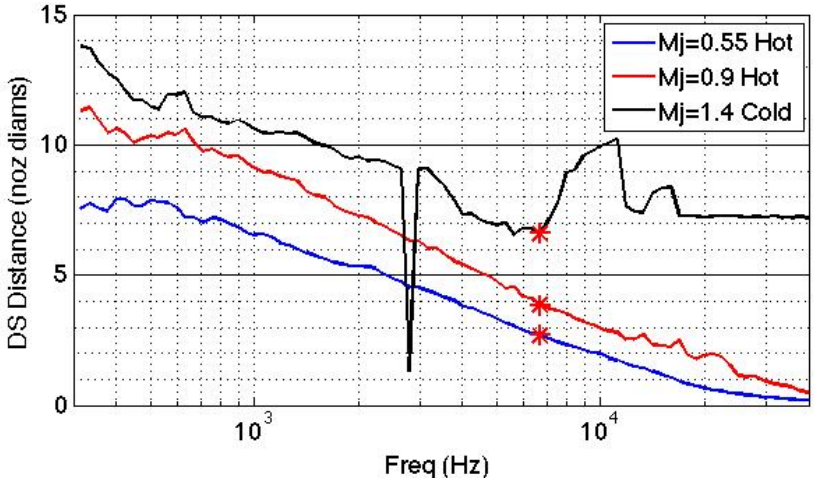

Mj=0.55 Hot
Mj=0.9 Hot
Mj=1.4 Cold
1/12th OB Array Median SPL (dB)
120
110
100
90
80
70
10^3
10^4

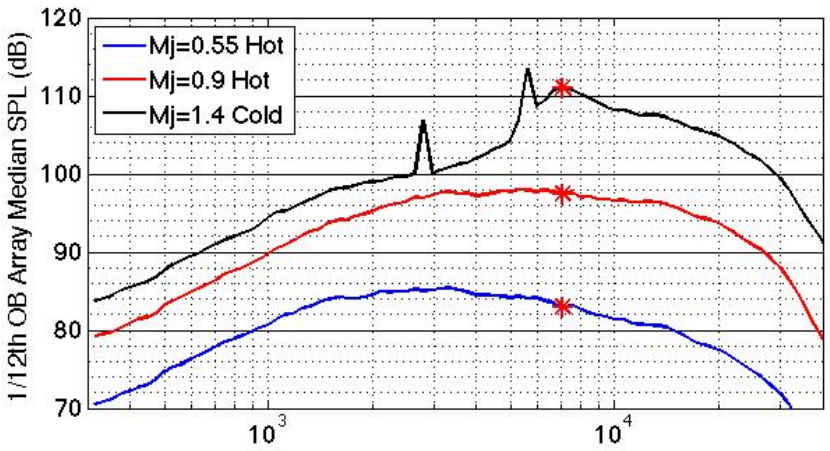

6300.0 Hz
78.5 in.
90
dB
83

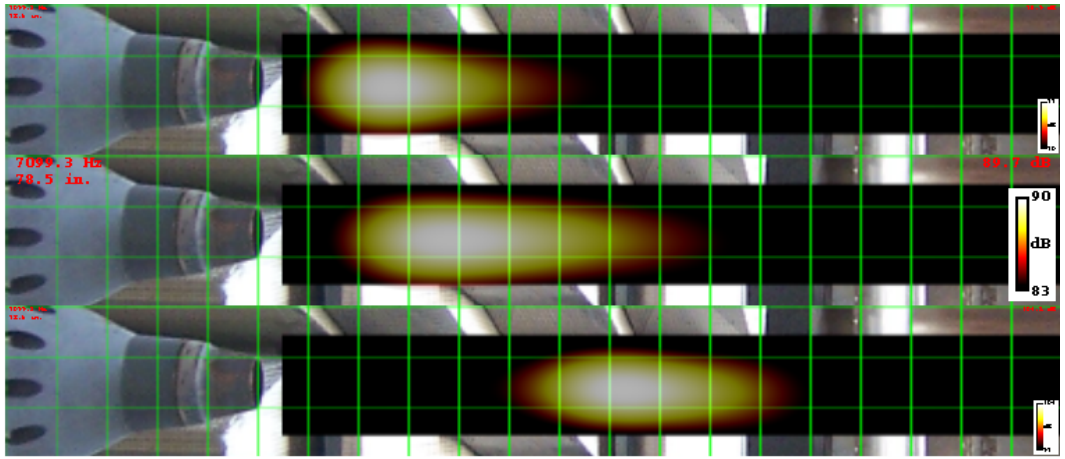

Mj=0.55 Hot
Mj=0.9 Hot
Mj=1.4 Cold
DS Distance (noz diams)
15
10
5
0
10^3
10^4
Freq (Hz)

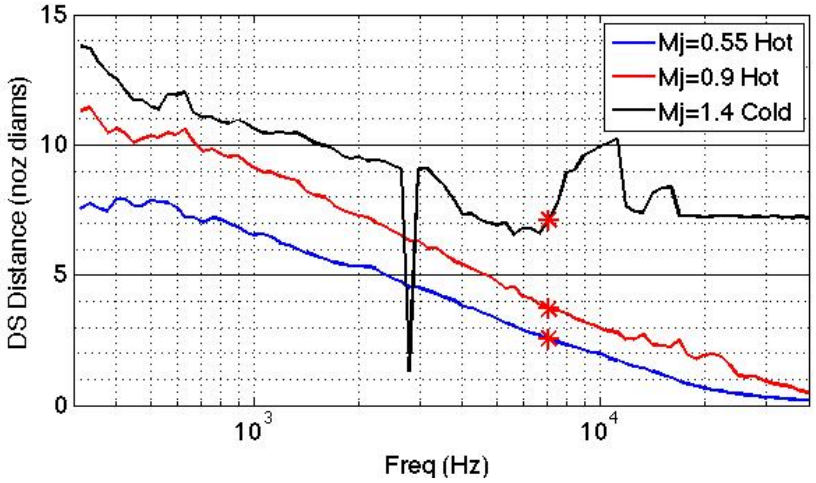

Mj=0.55 Hot
Mj=0.9 Hot
Mj=1.4 Cold
1/12th OB Array Median SPL (dB)
120
110
100
90
80
70
10^3
10^4

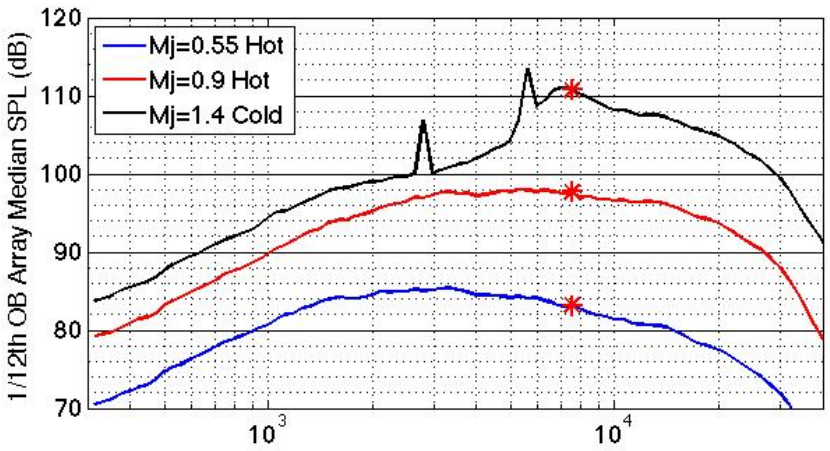

6687.7 Hz
78.5 in.
90
dB
83

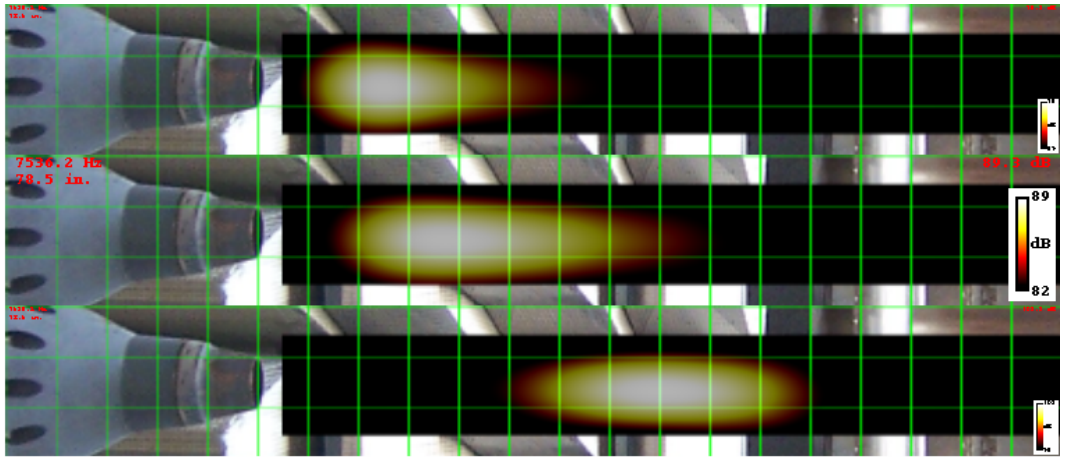

Mj=0.55 Hot
Mj=0.9 Hot
Mj=1.4 Cold
DS Distance (noz diams)
15
10
5
0
10^3
10^4
Freq (Hz)

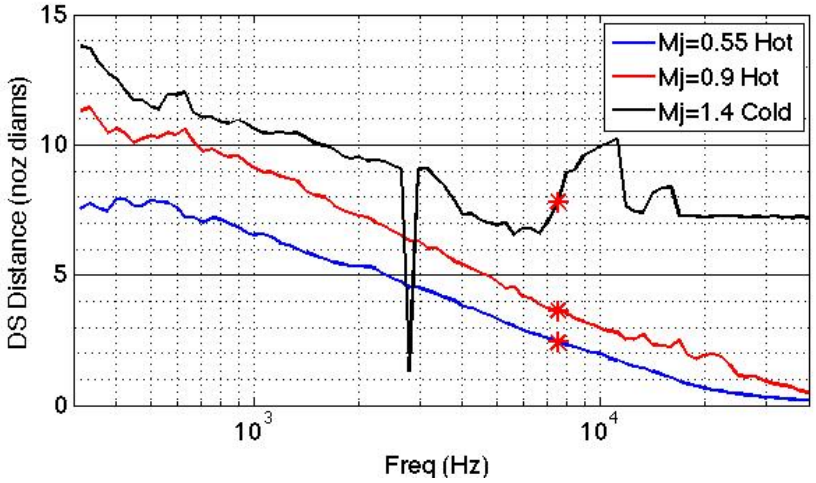

Mj=0.55 Hot
Mj=0.9 Hot
Mj=1.4 Cold
1/12th OB Array Median SPL (dB)
120
110
100
90
80
70
10^3
10^4

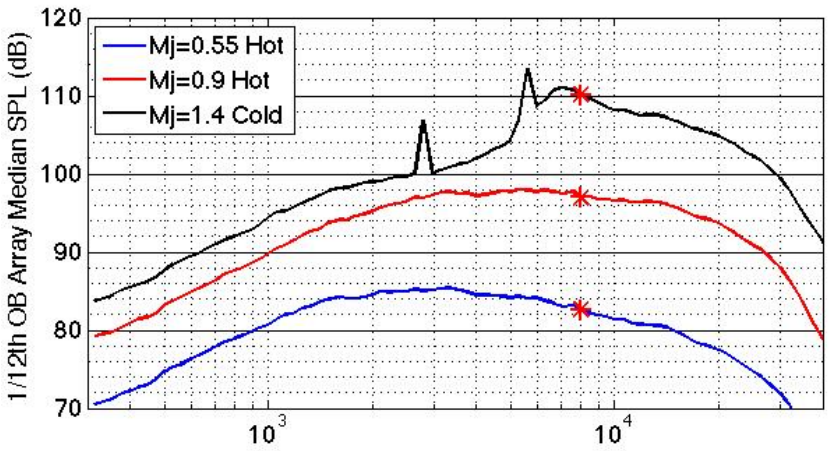

7099.3 Hz
78.5 in.
90
dB
83

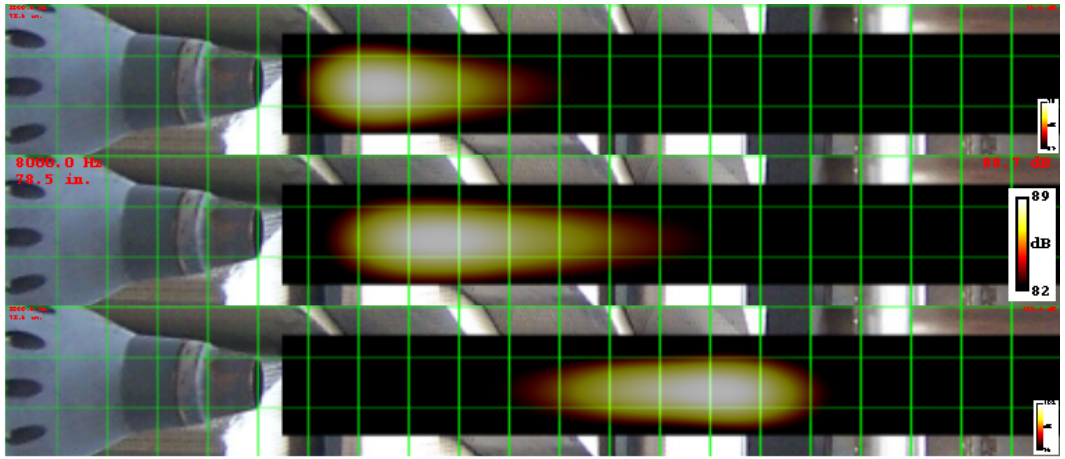

Mj=0.55 Hot
Mj=0.9 Hot
Mj=1.4 Cold
DS Distance (noz diams)
15
10
5
0
10^3
10^4
Freq (Hz)

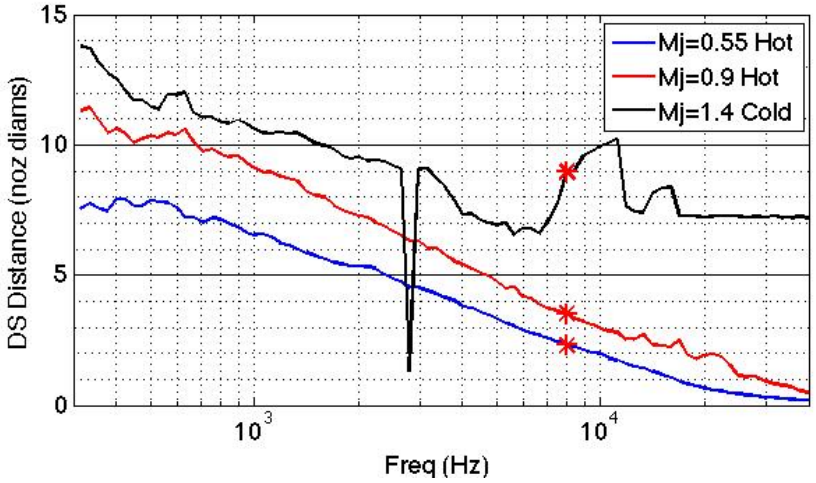

Mj=0.55 Hot
Mj=0.9 Hot
Mj=1.4 Cold
1/12th OB Array Median SPL (dB)
120
110
100
90
80
70
10^3
10^4

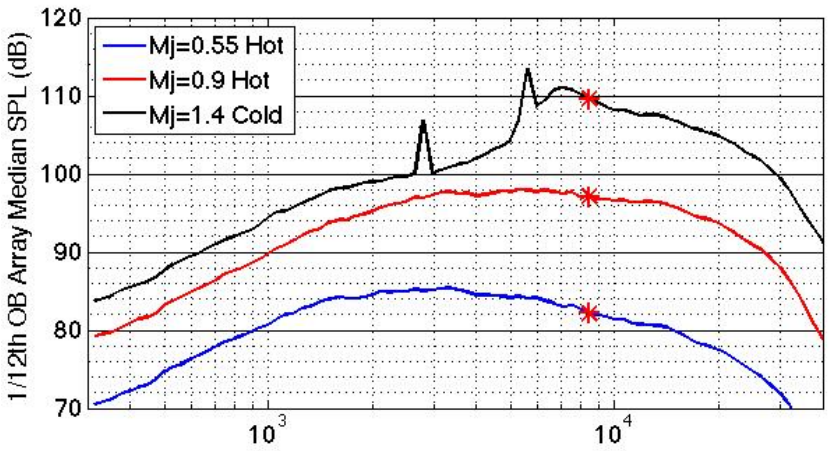

7530.2 Hz
78.5 in.
89
dB
82

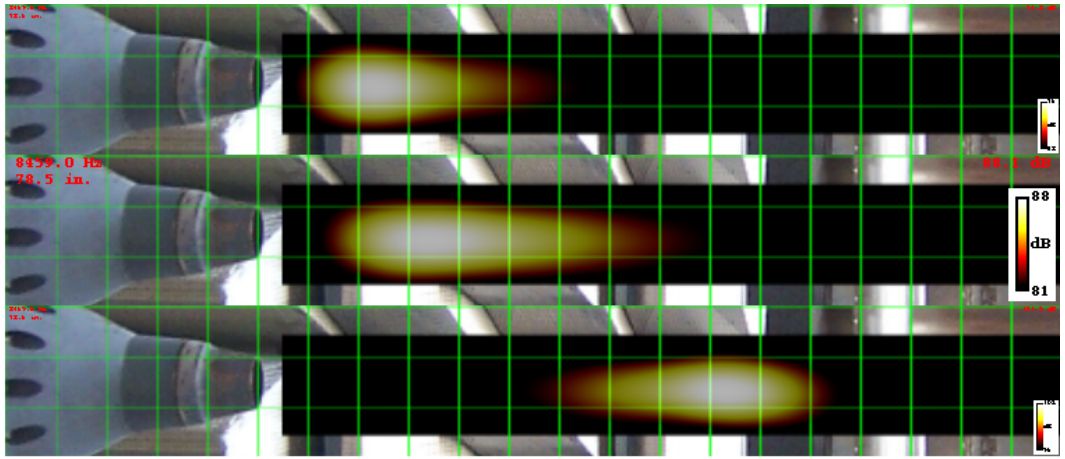

Mj=0.55 Hot
Mj=0.9 Hot
Mj=1.4 Cold
DS Distance (noz diams)
15
10
5
0
10^3
10^4
Freq (Hz)

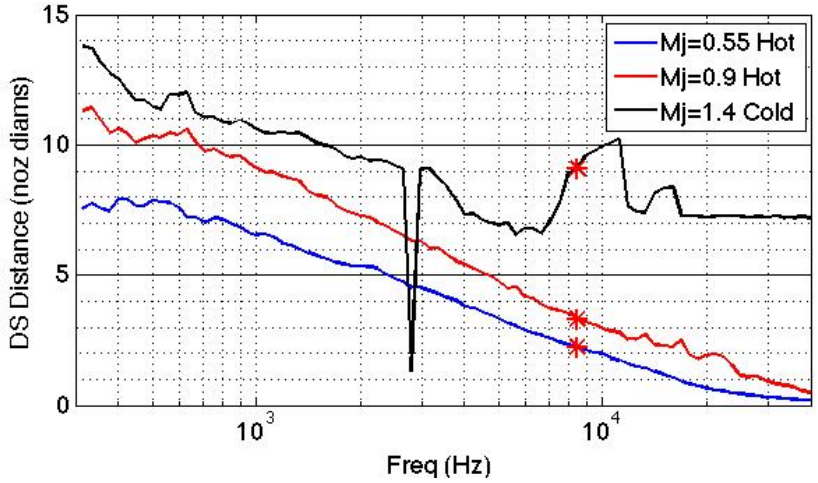

Mj=0.55 Hot
Mj=0.9 Hot
Mj=1.4 Cold
1/12th OB Array Median SPL (dB)
120
110
100
90
80
70
10^3
10^4

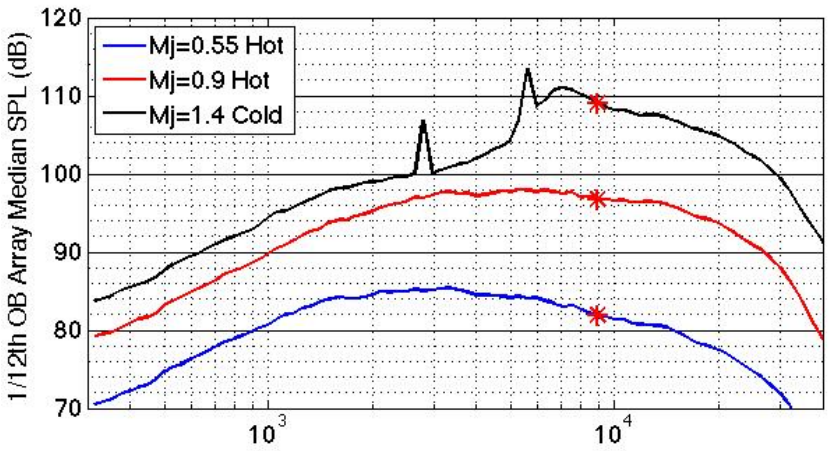

8000.0 Hz
78.5 in.
89
dB
82

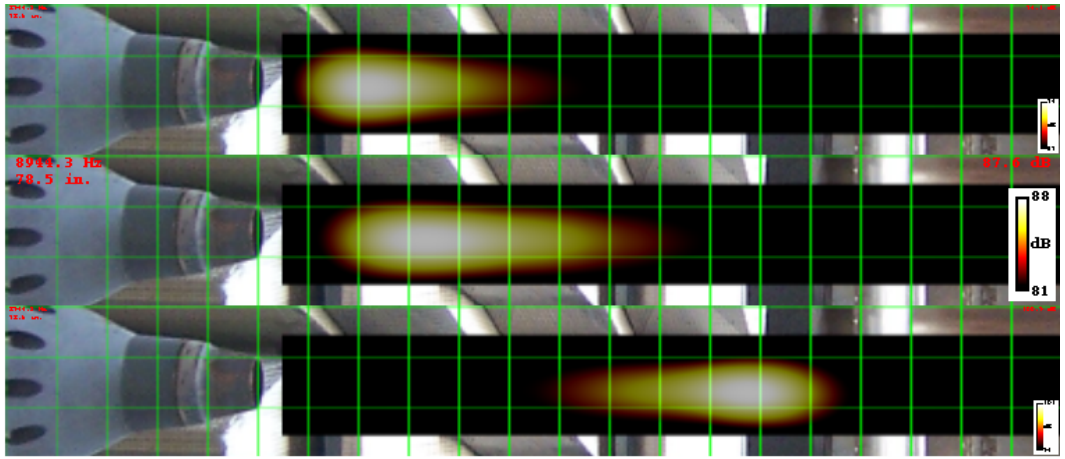

Mj=0.55 Hot
Mj=0.9 Hot
Mj=1.4 Cold
DS Distance (noz diams)
15
10
5
0
10^3
10^4
Freq (Hz)

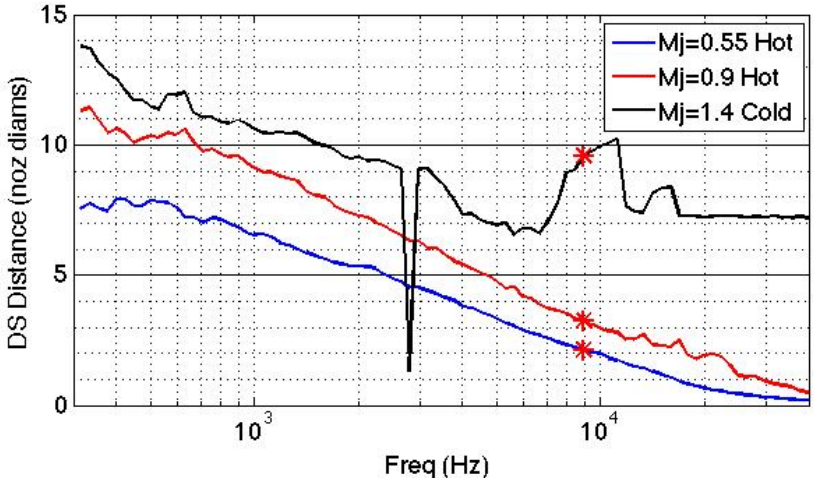

Mj=0.55 Hot
Mj=0.9 Hot
Mj=1.4 Cold
1/12th OB Array Median SPL (dB)
120
110
100
90
80
70
10^3
10^4

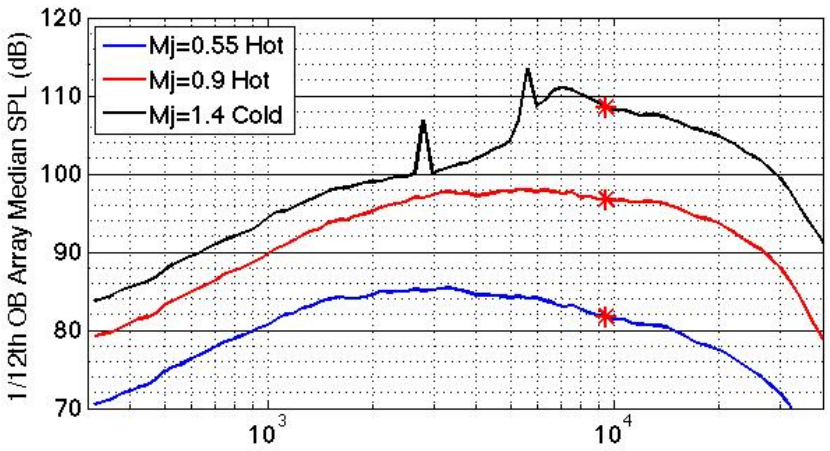

8479.0 Hz
78.5 in.
88
dB
81

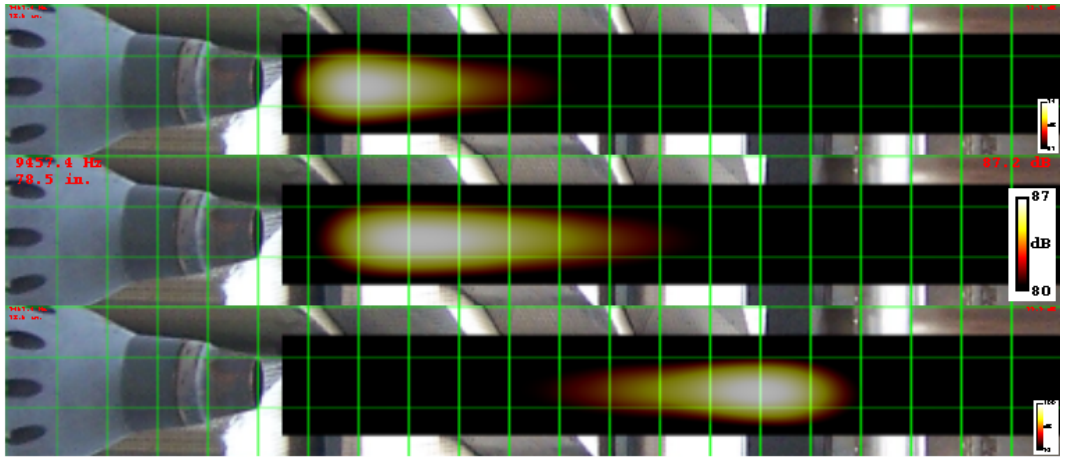

Mj=0.55 Hot
Mj=0.9 Hot
Mj=1.4 Cold
DS Distance (noz diams)
15
10
5
0
10^3
10^4
Freq (Hz)

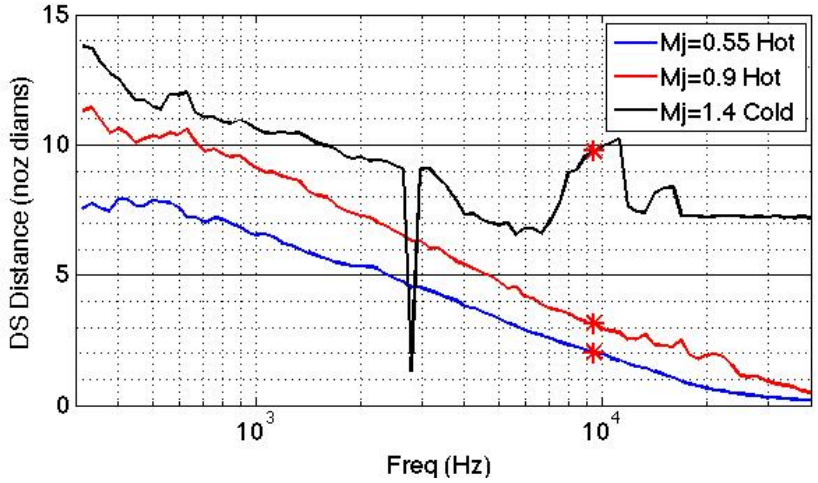

Mj=0.55 Hot
Mj=0.9 Hot
Mj=1.4 Cold
1/12th OB Array Median SPL (dB)
120
110
100
90
80
70
10^3
10^4

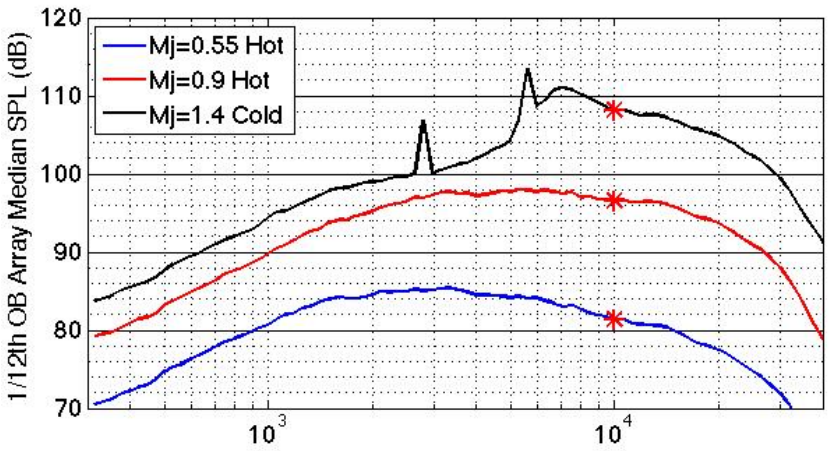

8944.3 Hz
78.5 in.
88
dB
81

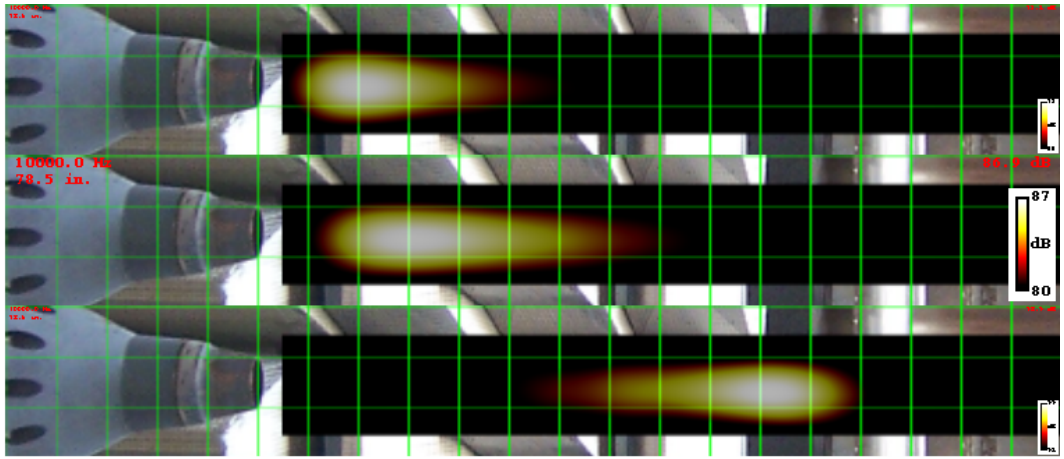

Mj=0.55 Hot
Mj=0.9 Hot
Mj=1.4 Cold
DS Distance (noz diams)
15
10
5
0
10^3
10^4
Freq (Hz)

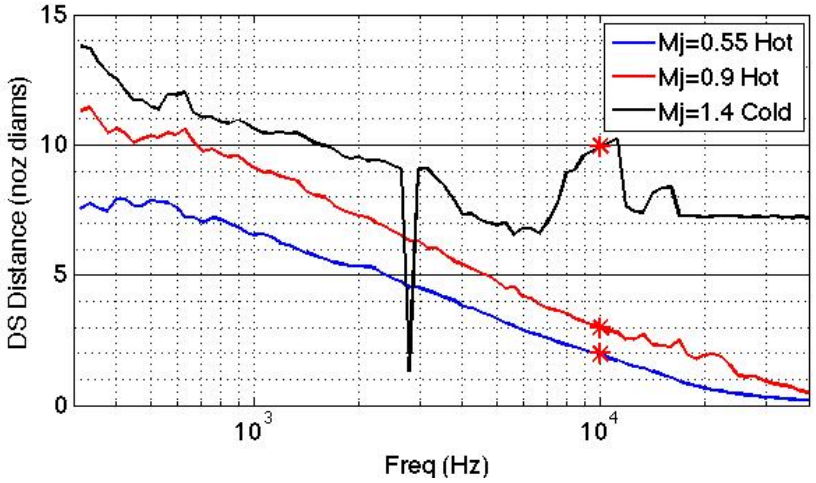

Mj=0.55 Hot
Mj=0.9 Hot
Mj=1.4 Cold
1/12th OB Array Median SPL (dB)
120
110
100
90
80
70
10^3
10^4

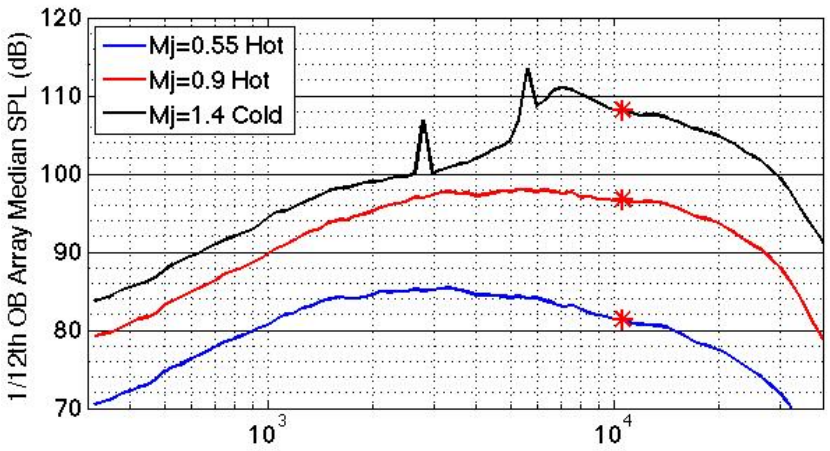

9437.4 Hz
78.5 in.
87
dB
80

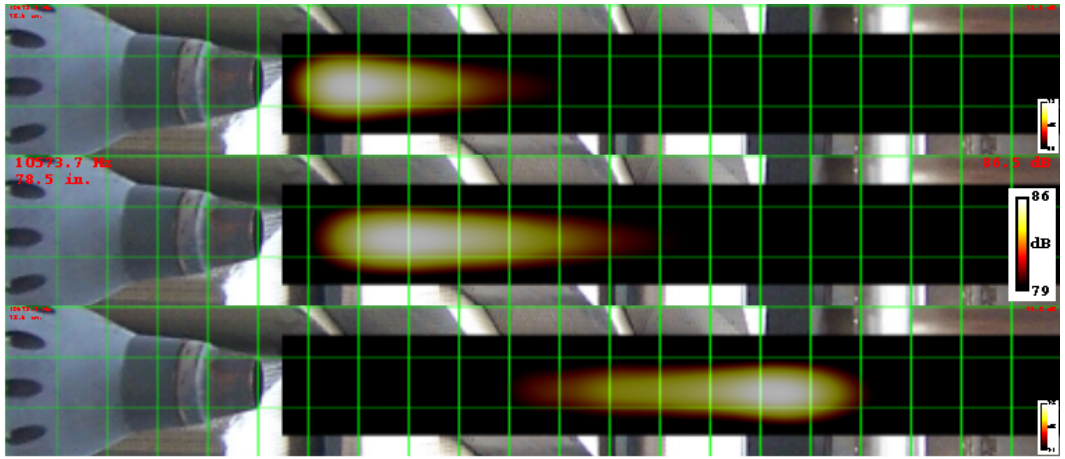

Mj=0.55 Hot
Mj=0.9 Hot
Mj=1.4 Cold
DS Distance (noz diams)
15
10
5
0
10^3
10^4
Freq (Hz)

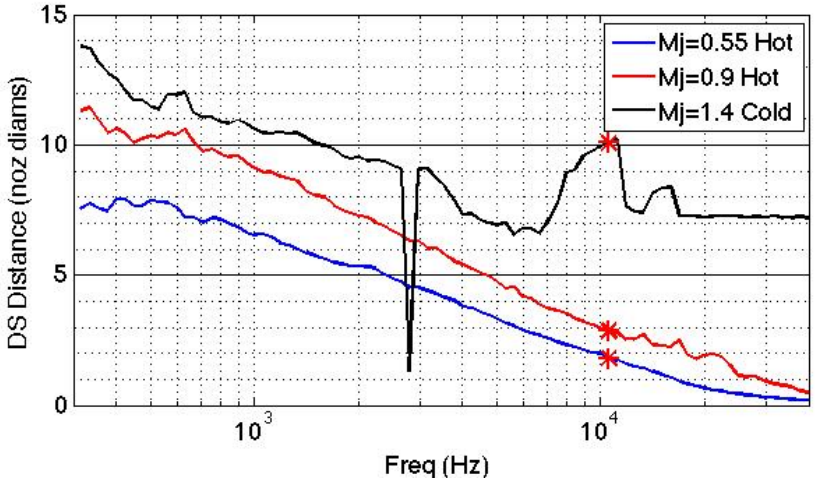

Mj=0.55 Hot
Mj=0.9 Hot
Mj=1.4 Cold
1/12th OB Array Median SPL (dB)
120
110
100
90
80
70
10^3
10^4

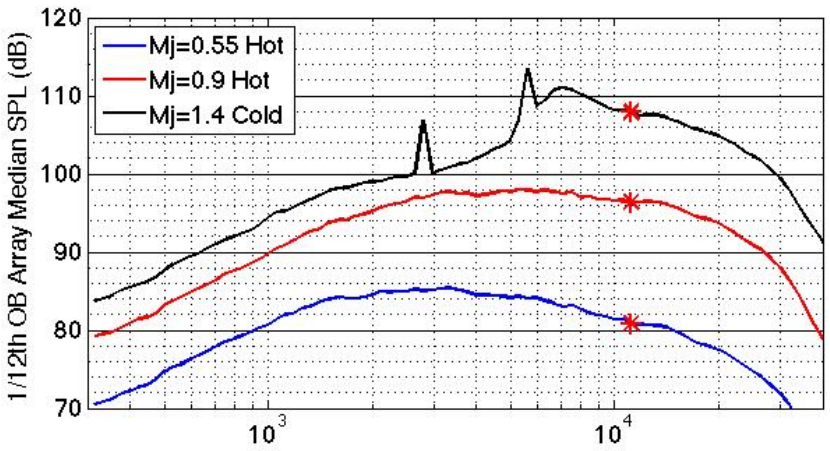

10000.0 Hz
78.5 in.
87
dB
80

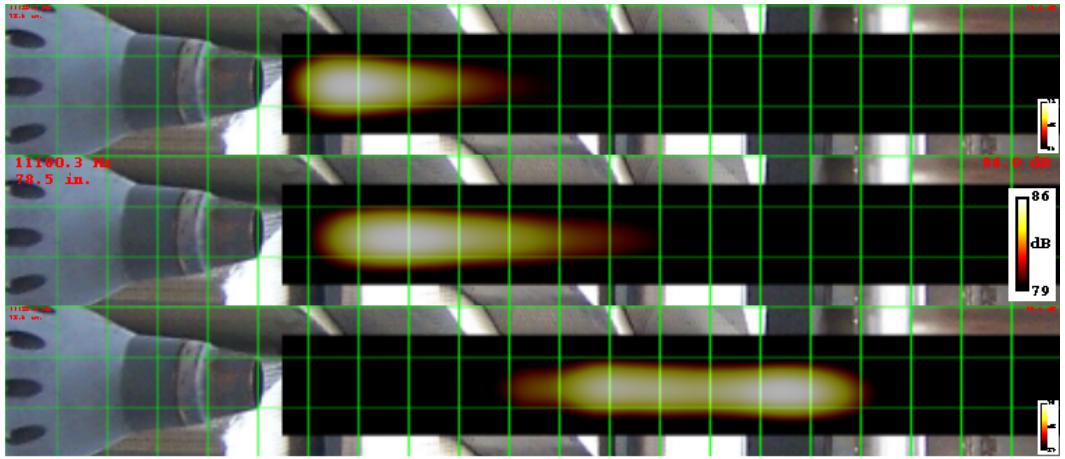

Mj=0.55 Hot
Mj=0.9 Hot
Mj=1.4 Cold
DS Distance (noz diams)
15
10
5
0
10^3
10^4
Freq (Hz)

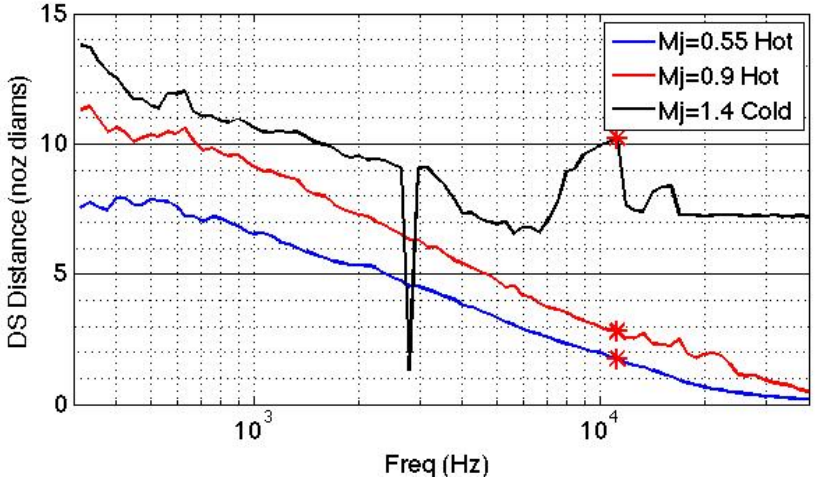

Mj=0.55 Hot
Mj=0.9 Hot
Mj=1.4 Cold
1/12th OB Array Median SPL (dB)
120
110
100
90
80
70
10^3
10^4

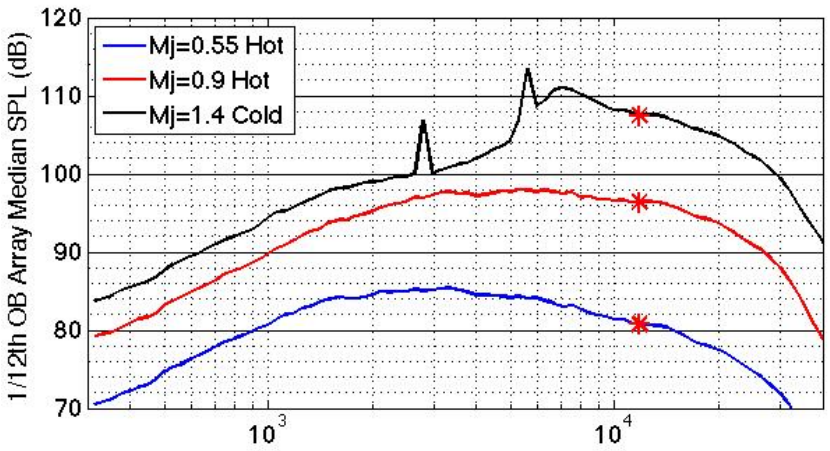

10573.7 Hz
78.5 in.
86
dB
79

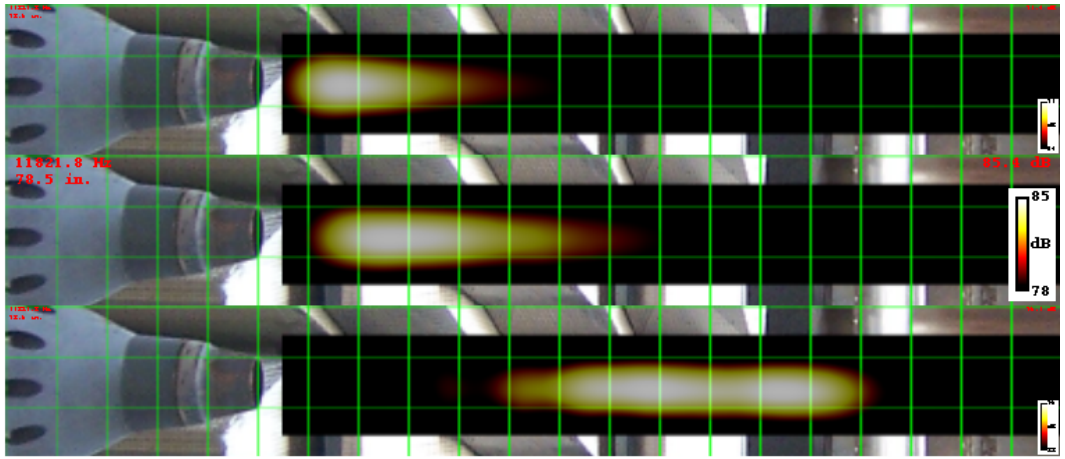

Mj=0.55 Hot
Mj=0.9 Hot
Mj=1.4 Cold
DS Distance (noz diams)
15
10
5
0
10^3
10^4
Freq (Hz)

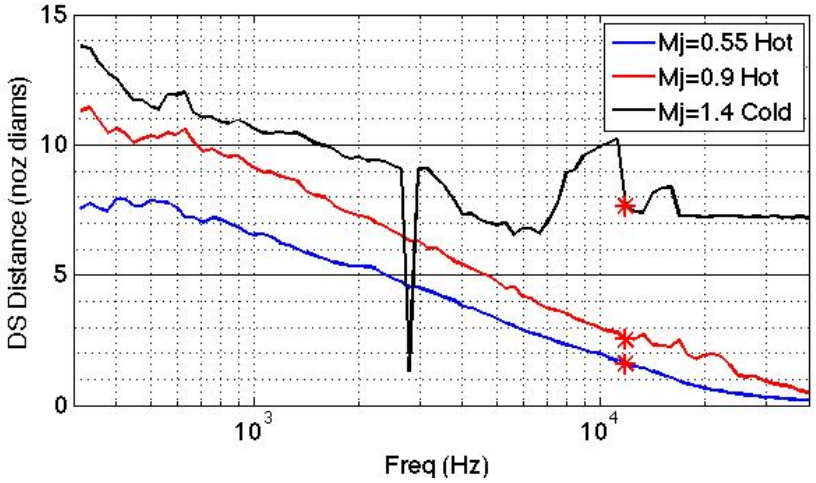

Mj=0.55 Hot
Mj=0.9 Hot
Mj=1.4 Cold
1/12th OB Array Median SPL (dB)
120
110
100
90
80
70
10^3
10^4

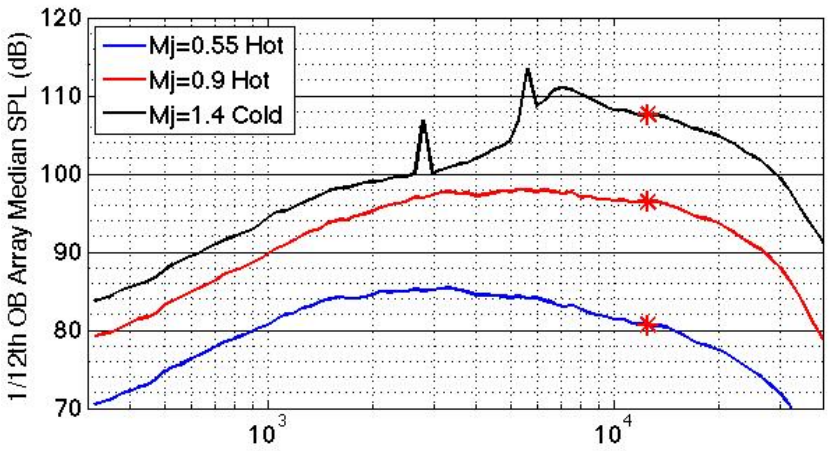

11100.3 Hz
78.5 in.
86
dB
79

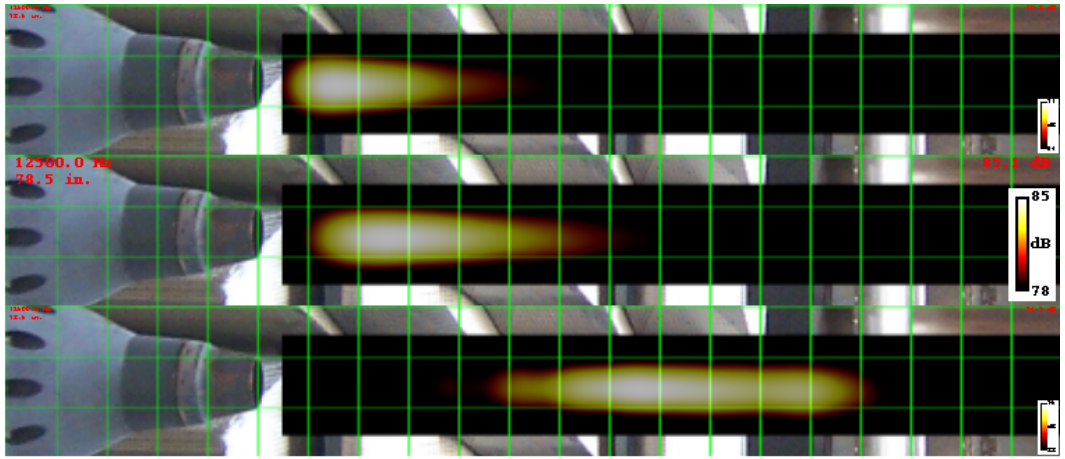

Mj=0.55 Hot
Mj=0.9 Hot
Mj=1.4 Cold
DS Distance (noz diams)
15
10
5
0
10^3
10^4
Freq (Hz)

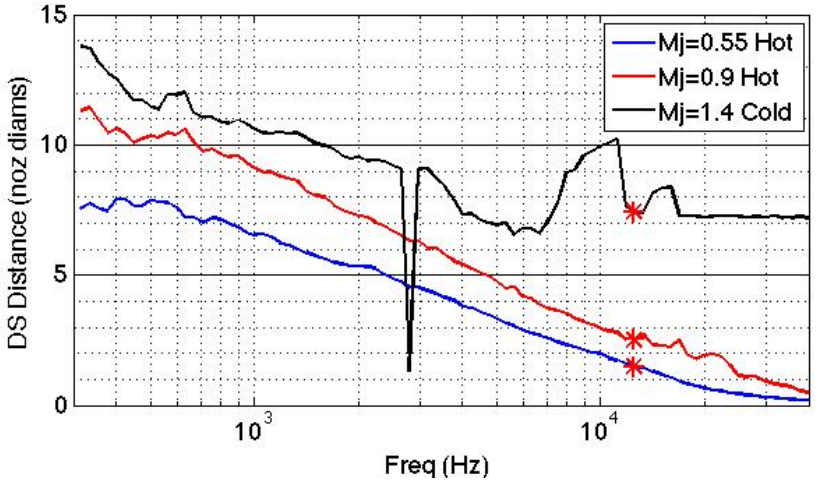

Mj=0.55 Hot
Mj=0.9 Hot
Mj=1.4 Cold
1/12th OB Array Median SPL (dB)
120
110
100
90
80
70
10^3
10^4

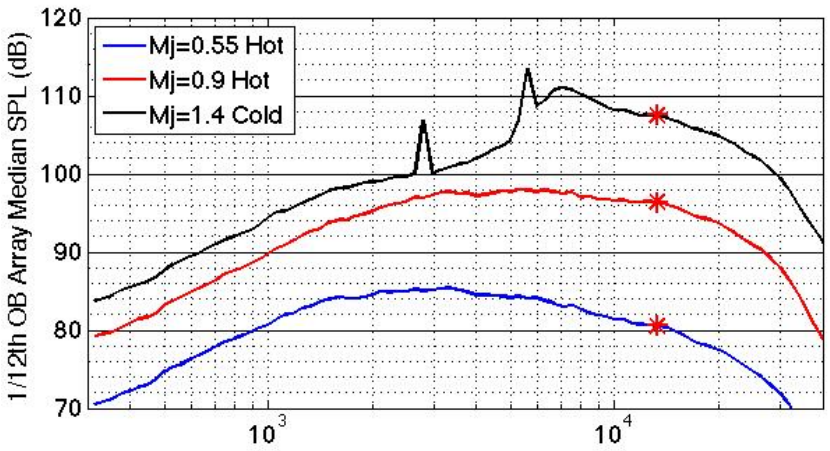

11021.8 Hz
78.5 in.
85
dB
78

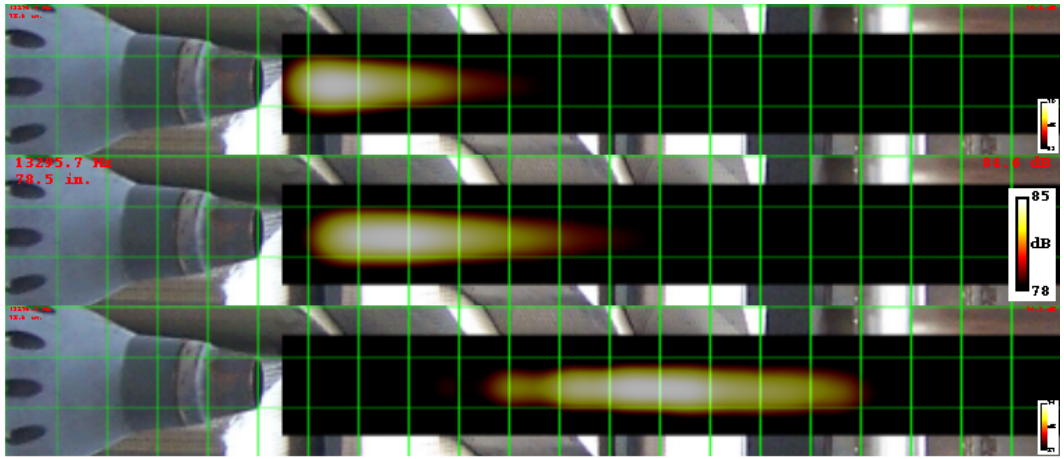

Mj=0.55 Hot
Mj=0.9 Hot
Mj=1.4 Cold
DS Distance (noz diams)
15
10
5
0
10^3
10^4
Freq (Hz)

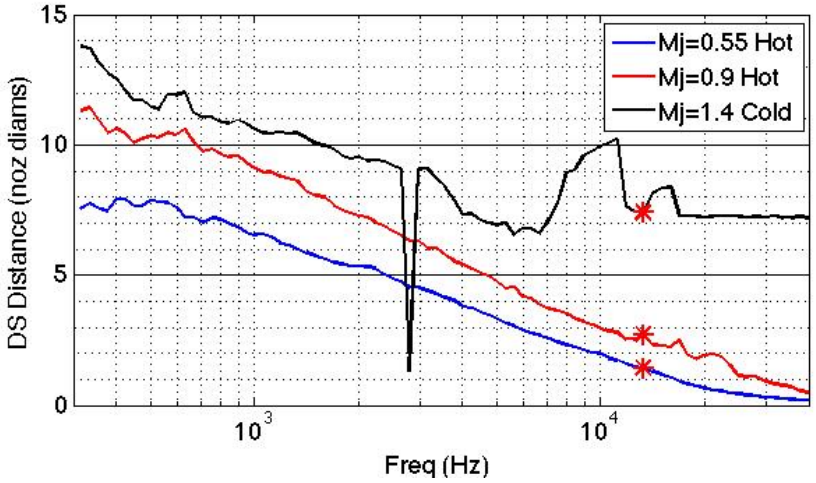

Mj=0.55 Hot
Mj=0.9 Hot
Mj=1.4 Cold
1/12th OB Array Median SPL (dB)
120
110
100
90
80
70
10^3
10^4

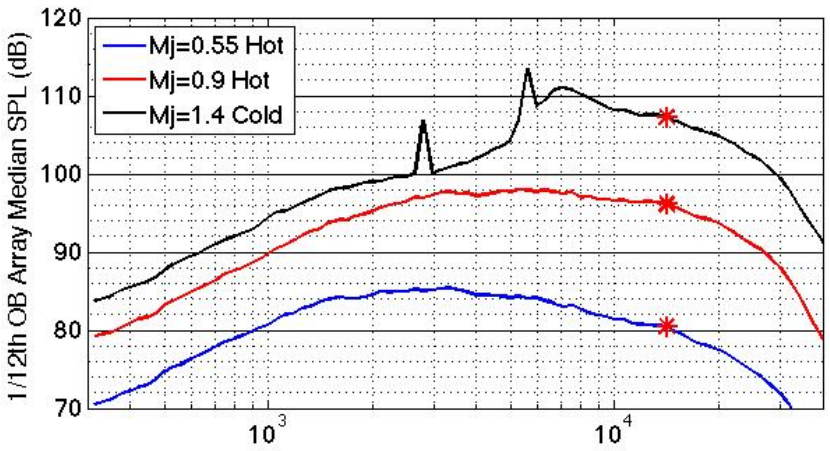

12500.0 Hz
78.5 in.
85
dB
78

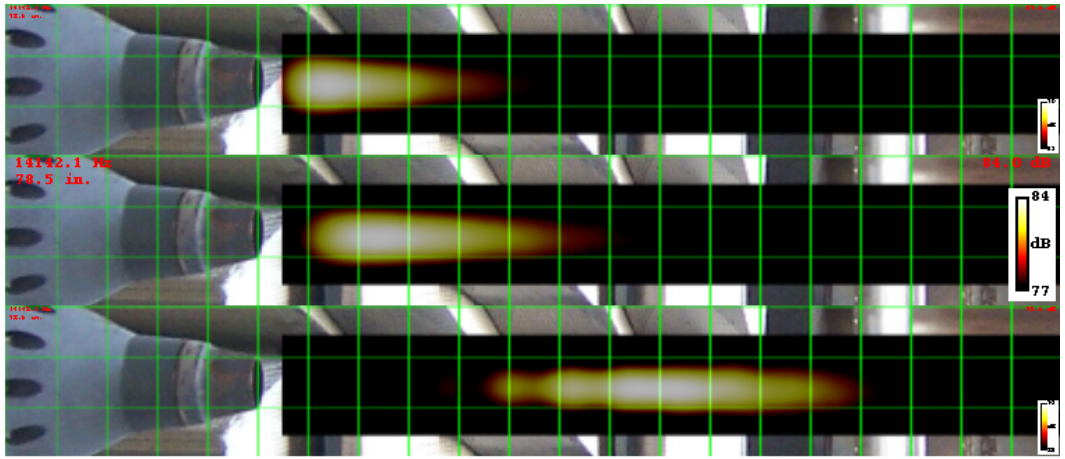

Mj=0.55 Hot
Mj=0.9 Hot
Mj=1.4 Cold
DS Distance (noz diams)
15
10
5
0
10^3
10^4
Freq (Hz)

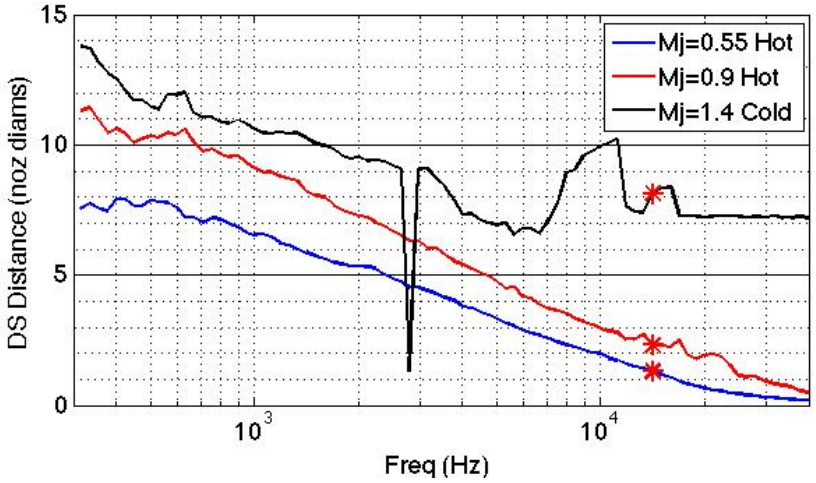

Mj=0.55 Hot
Mj=0.9 Hot
Mj=1.4 Cold
1/12th OB Array Median SPL (dB)
120
110
100
90
80
70
10^3
10^4

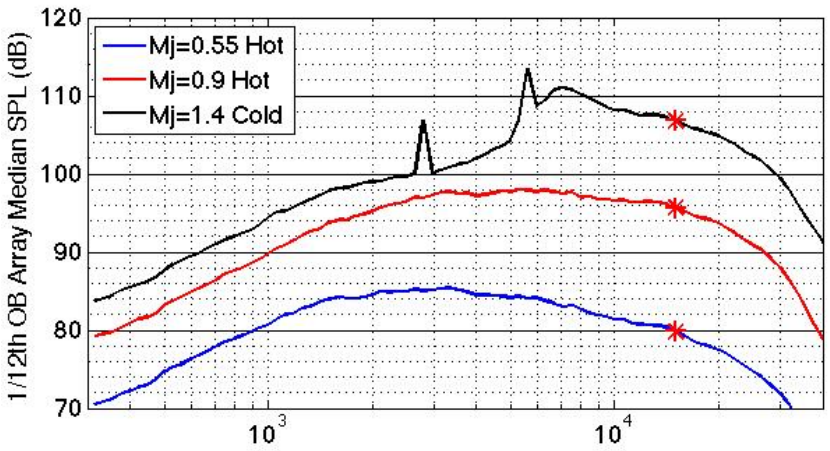

13295.7 Hz
78.5 in.
85
dB
78

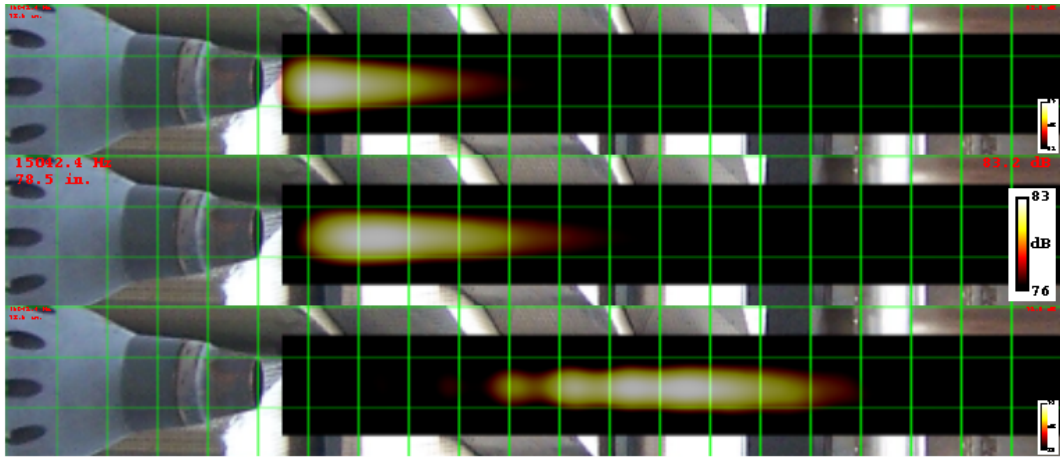

Mj=0.55 Hot
Mj=0.9 Hot
Mj=1.4 Cold
DS Distance (noz diams)
15
10
5
0
10^3
10^4
Freq (Hz)

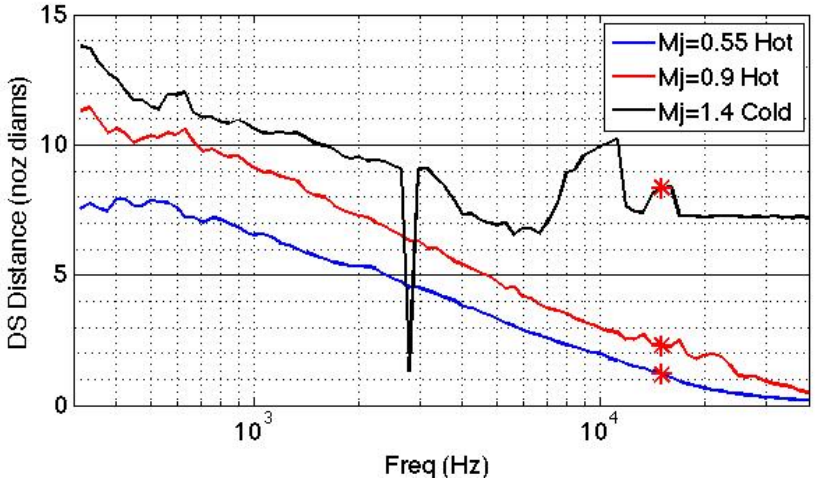

1/12th OB Array Median SPL (dB)
120
110
100
90
80
70
Mj=0.55 Hot
Mj=0.9 Hot
Mj=1.4 Cold
10^3
10^4

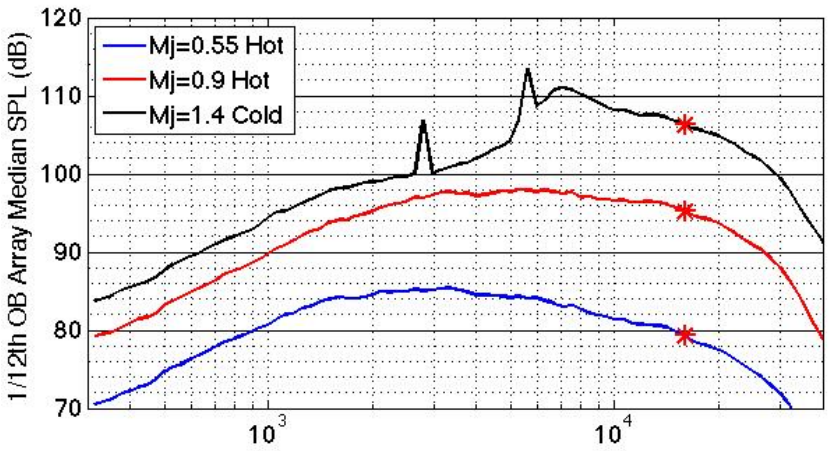

14142.1 Hz
78.5 in.
84
dB
77

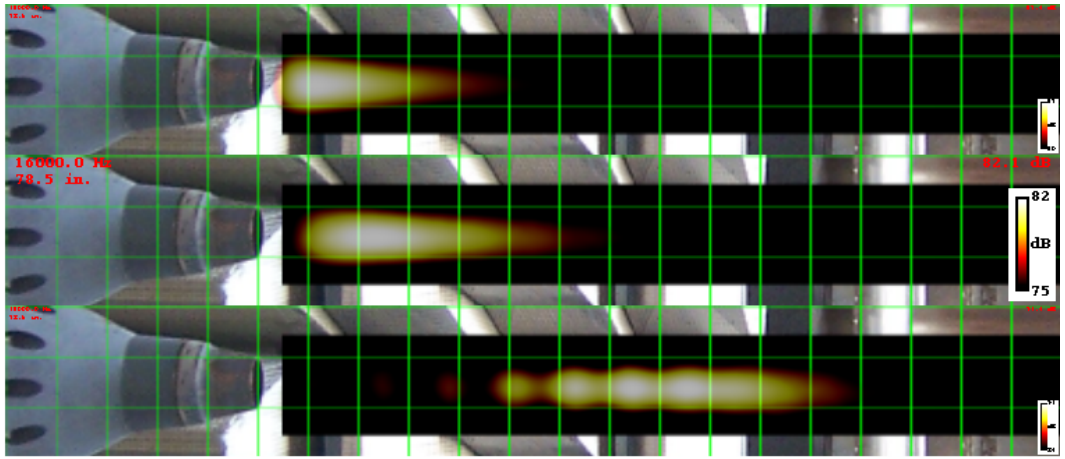

DS Distance (noz diams)
15
10
5
0
Mj=0.55 Hot
Mj=0.9 Hot
Mj=1.4 Cold
10^3
10^4
Freq (Hz)

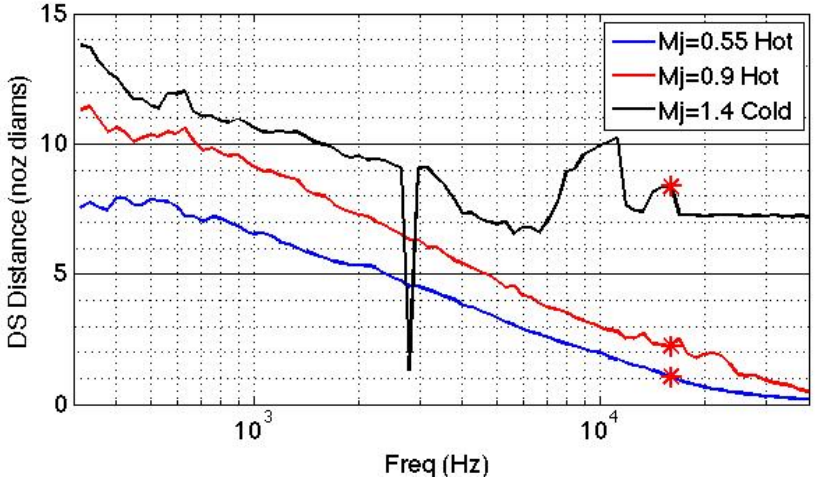

1/12th OB Array Median SPL (dB)
120
110
100
90
80
70
10^3
10^4
Mj=0.55 Hot
Mj=0.9 Hot
Mj=1.4 Cold

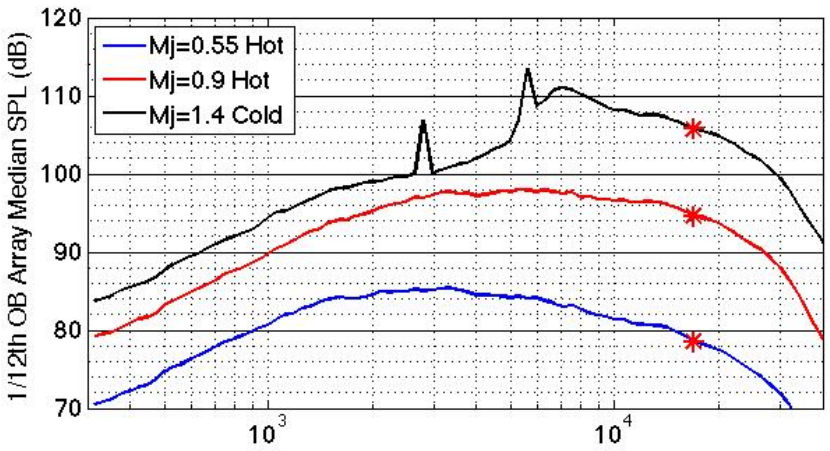

15042.4 Hz
78.5 in.
83
dB
76

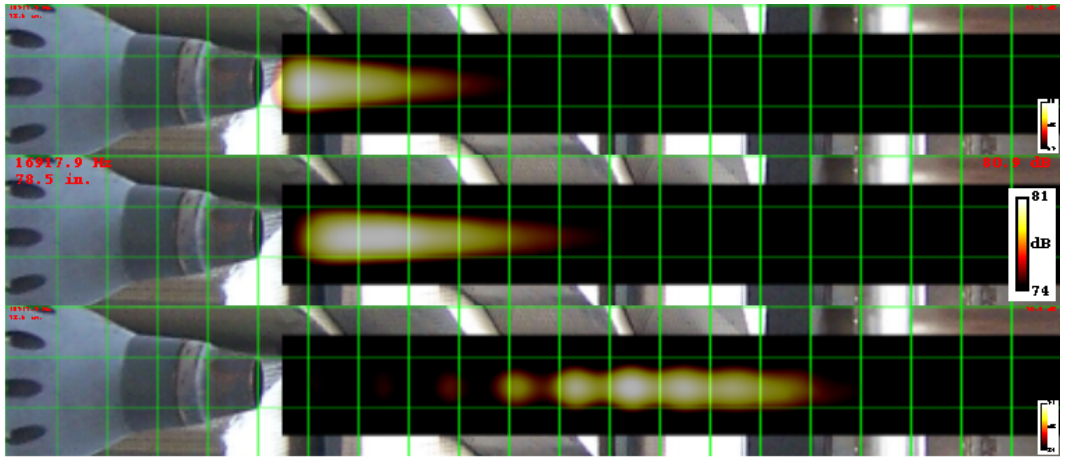

DS Distance (noz diams)
15
10
5
0
10^3
10^4
Freq (Hz)
Mj=0.55 Hot
Mj=0.9 Hot
Mj=1.4 Cold

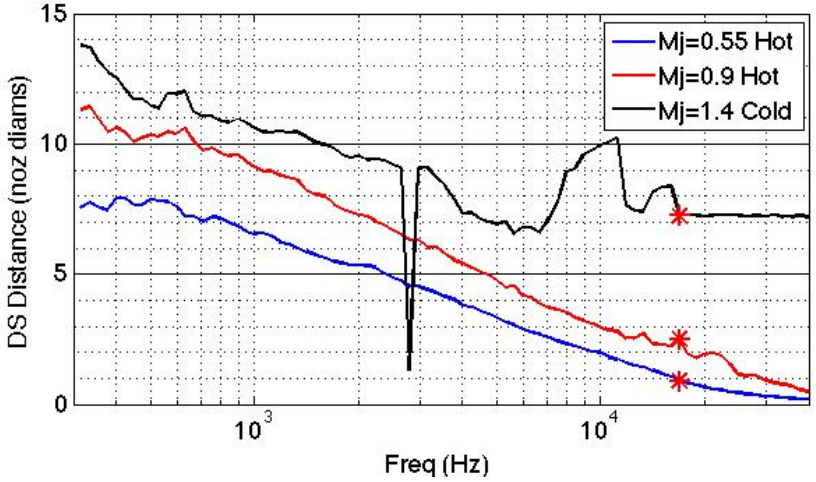

Mj=0.55 Hot
Mj=0.9 Hot
Mj=1.4 Cold
1/12th OB Array Median SPL (dB)
120
110
100
90
80
70
10^3
10^4

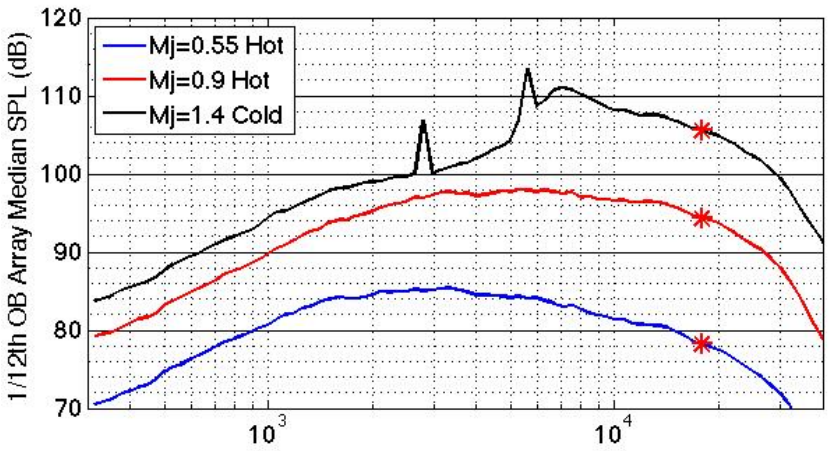

16000.0 Hz
78.5 in.
82.1 dB
82
dB
75

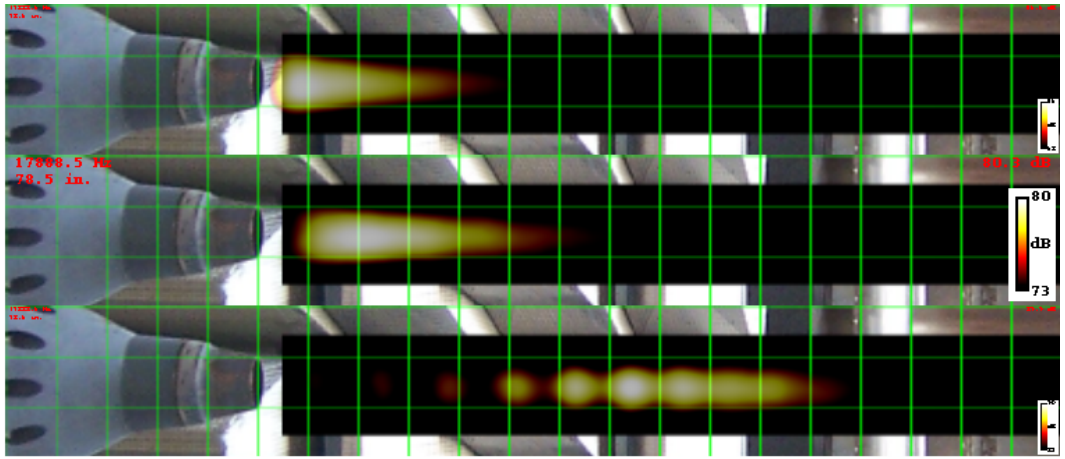

Mj=0.55 Hot
Mj=0.9 Hot
Mj=1.4 Cold
DS Distance (noz diams)
15
10
5
0
10^3
10^4
Freq (Hz)

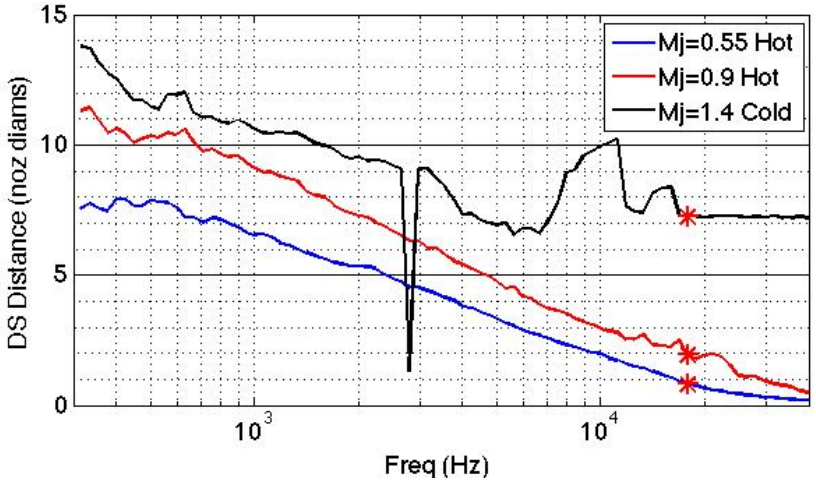

1/12th OB Array Median SPL (dB)
120
110
100
90
80
70
10^3
10^4
Mj=0.55 Hot
Mj=0.9 Hot
Mj=1.4 Cold

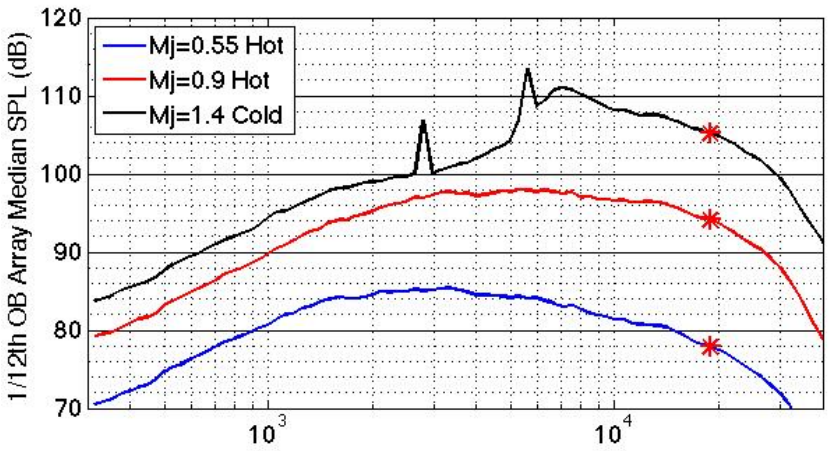

16977.9 Hz
78.5 in.
81
dB
74

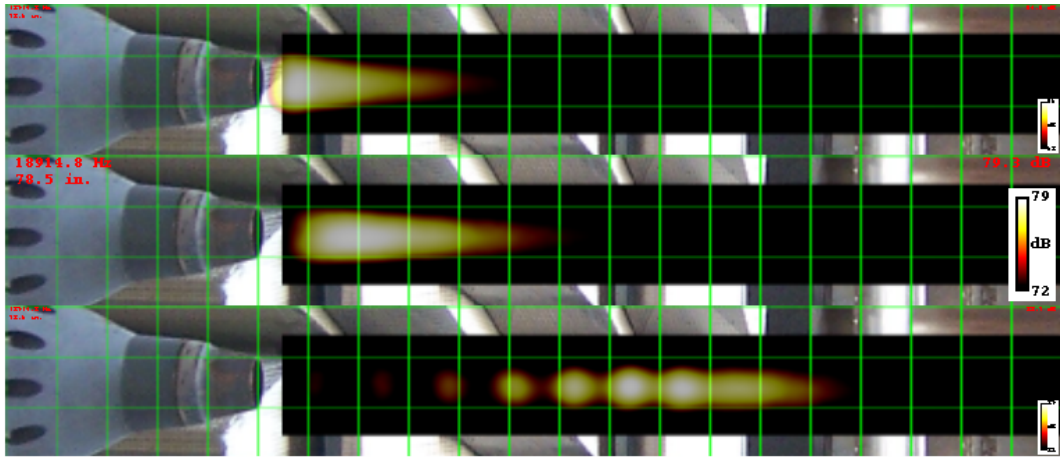

DS Distance (noz diams)
15
10
5
0
10^3
10^4
Freq (Hz)
Mj=0.55 Hot
Mj=0.9 Hot
Mj=1.4 Cold

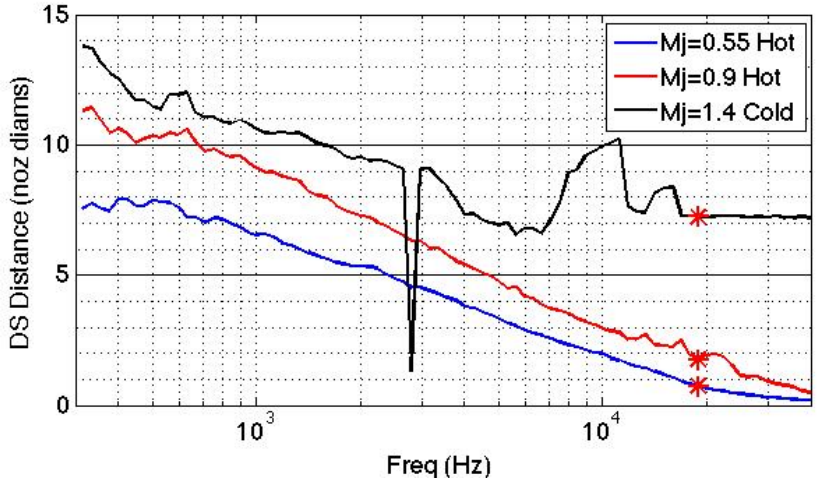

Mj=0.55 Hot
Mj=0.9 Hot
Mj=1.4 Cold
1/12th OB Array Median SPL (dB)
120
110
100
90
80
70
10^3
10^4

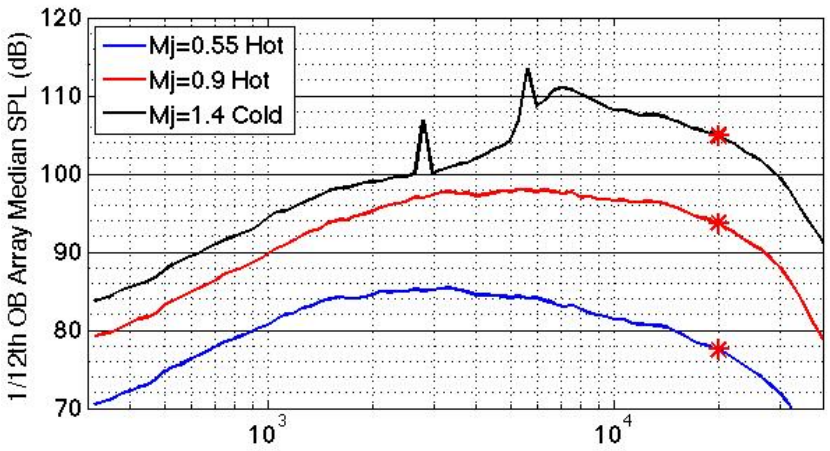

80
dB
73

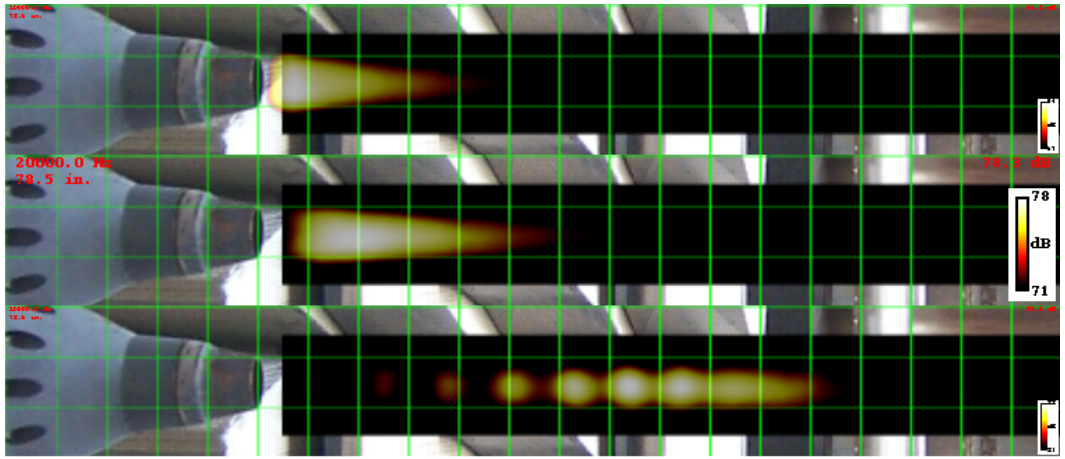

Mj=0.55 Hot
Mj=0.9 Hot
Mj=1.4 Cold
DS Distance (noz diams)
15
10
5
0
10^3
10^4
Freq (Hz)

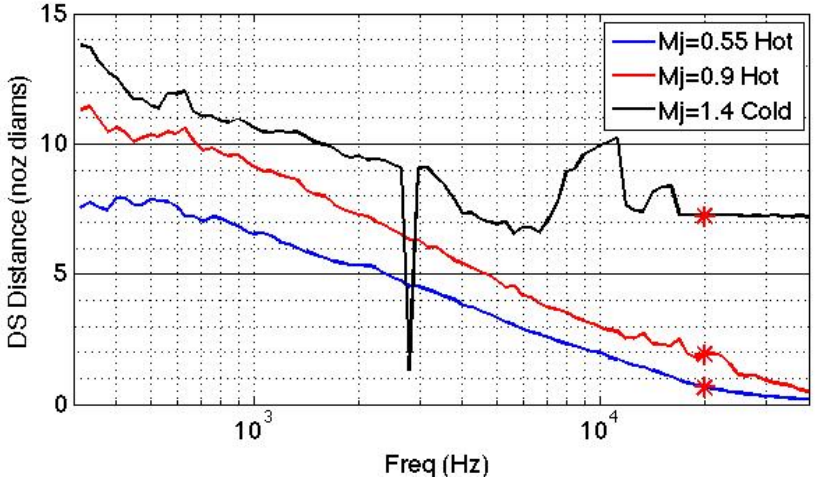

Mj=0.55 Hot
Mj=0.9 Hot
Mj=1.4 Cold
1/12th OB Array Median SPL (dB)
120
110
100
90
80
70
10^3
10^4

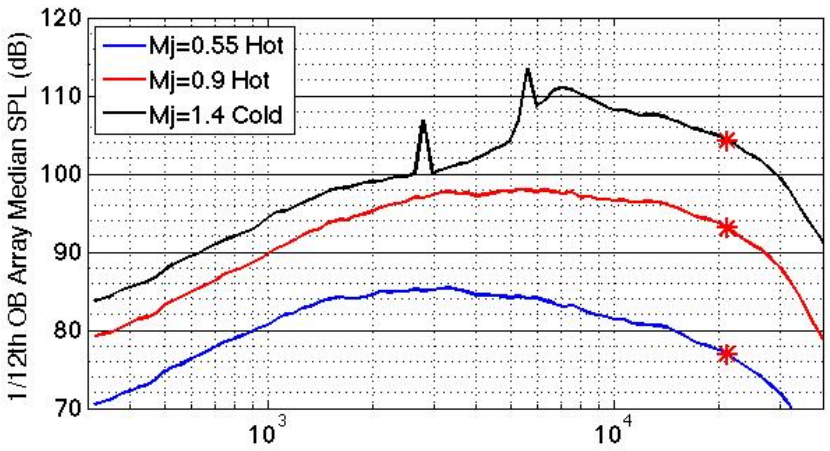

18974.8 Hz
78.5 in.
79
dB
72

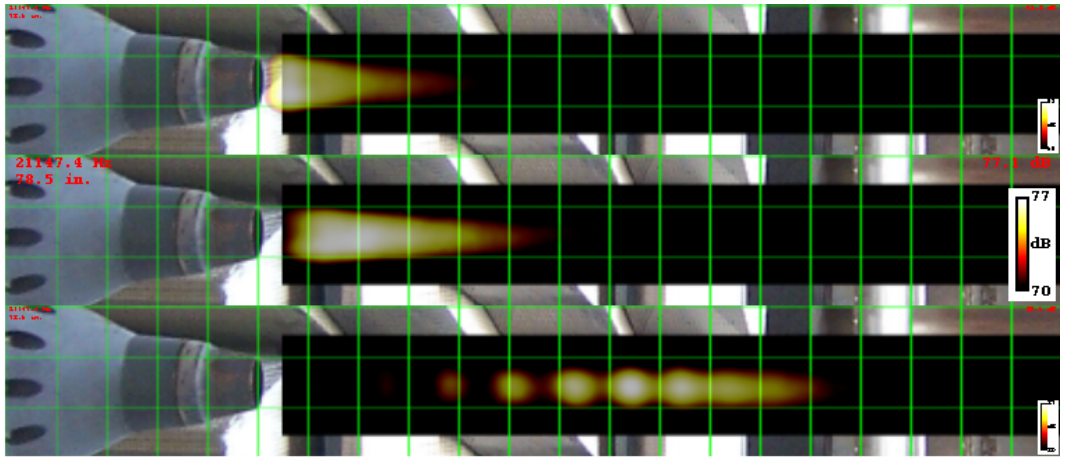

Mj=0.55 Hot
Mj=0.9 Hot
Mj=1.4 Cold
DS Distance (noz diams)
15
10
5
0
10^3
10^4
Freq (Hz)

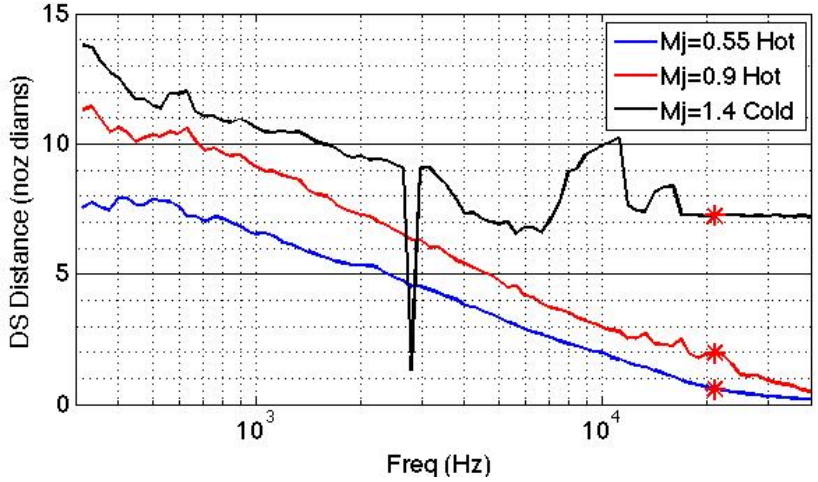

Mj=0.55 Hot
Mj=0.9 Hot
Mj=1.4 Cold
1/12th OB Array Median SPL (dB)
120
110
100
90
80
70
10^3
10^4

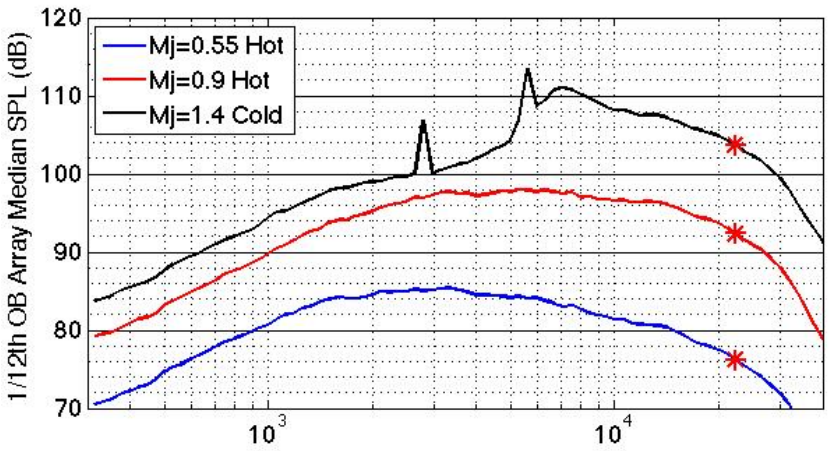

20000.0 Hz
78.5 in.
78.5 dB
78
dB
71

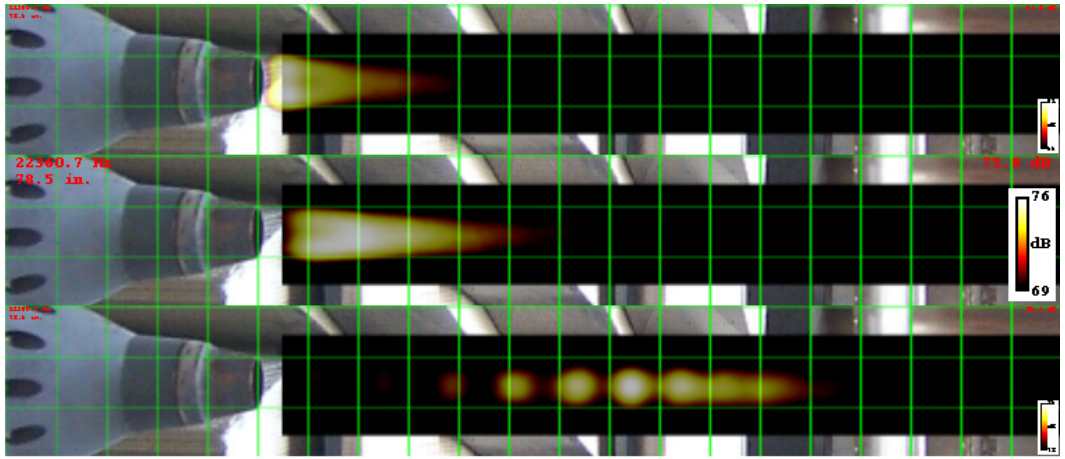

Mj=0.55 Hot
Mj=0.9 Hot
Mj=1.4 Cold
DS Distance (noz diams)
15
10
5
0
10^3
10^4
Freq (Hz)

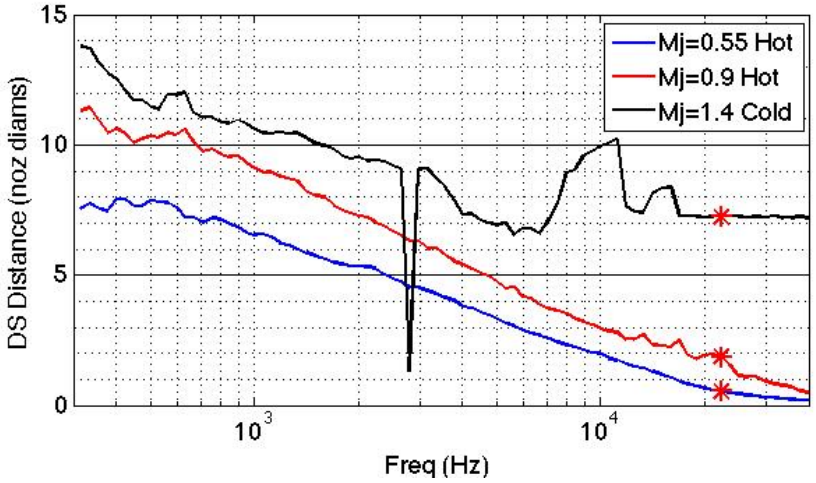

Mj=0.55 Hot
Mj=0.9 Hot
Mj=1.4 Cold
1/12th OB Array Median SPL (dB)
120
110
100
90
80
70
10^3
10^4

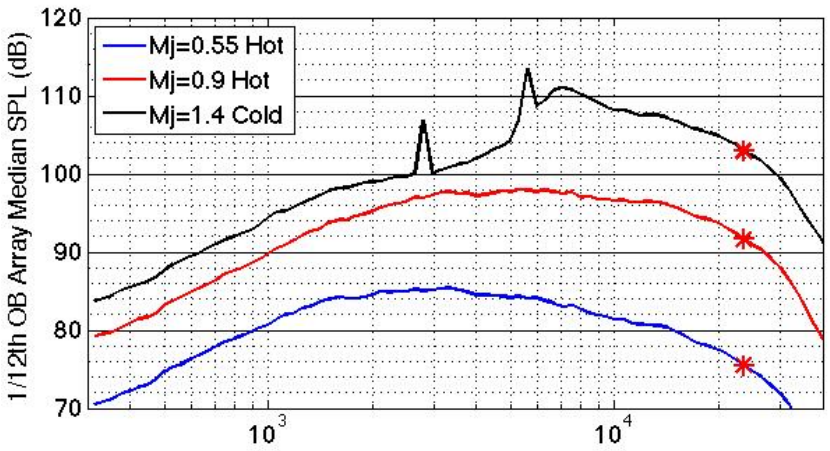

77
dB
70

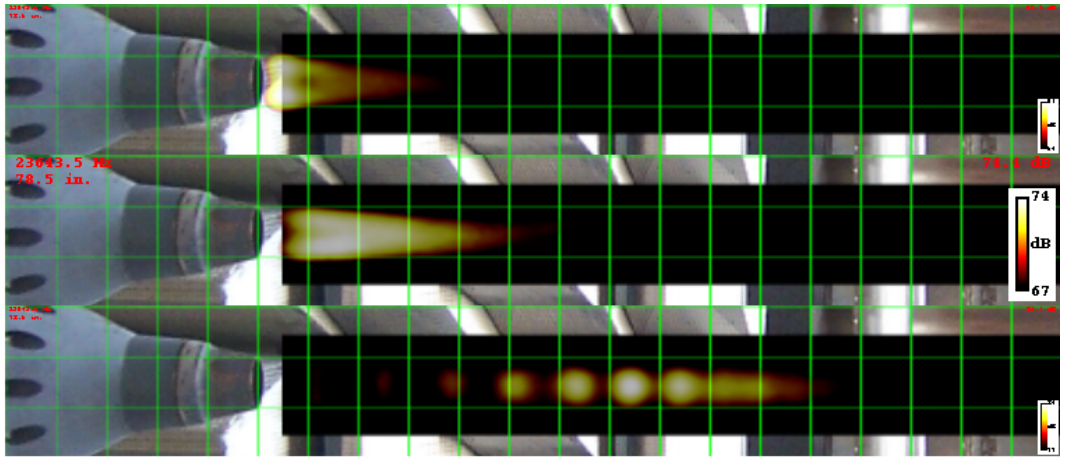

Mj=0.55 Hot
Mj=0.9 Hot
Mj=1.4 Cold
DS Distance (noz diams)
15
10
5
0
10^3
10^4
Freq (Hz)

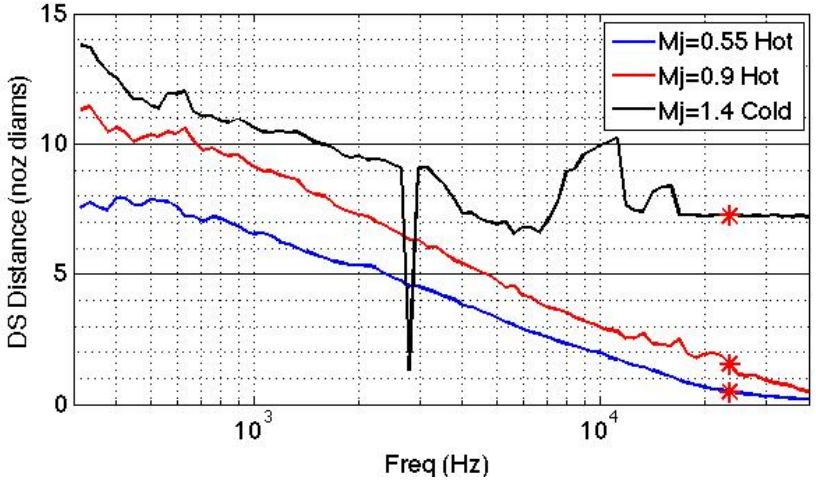

Mj=0.55 Hot
Mj=0.9 Hot
Mj=1.4 Cold
1/12th OB Array Median SPL (dB)
120
110
100
90
80
70
10^3
10^4

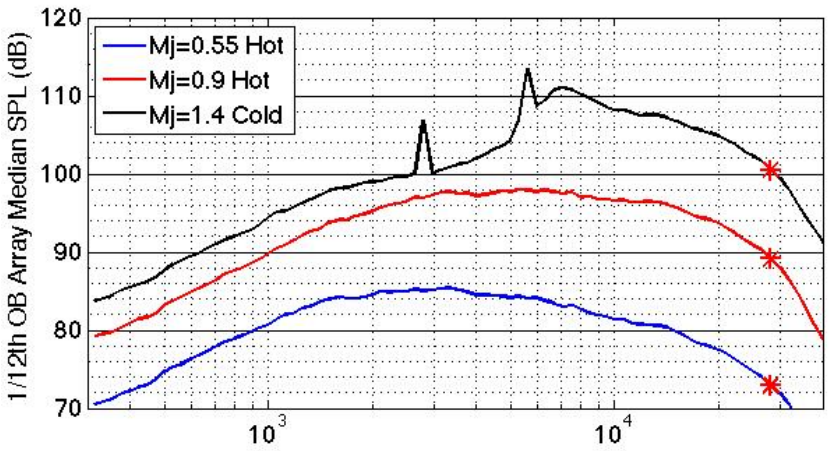

22360.7 Hz
78.5 in.
76
dB
69

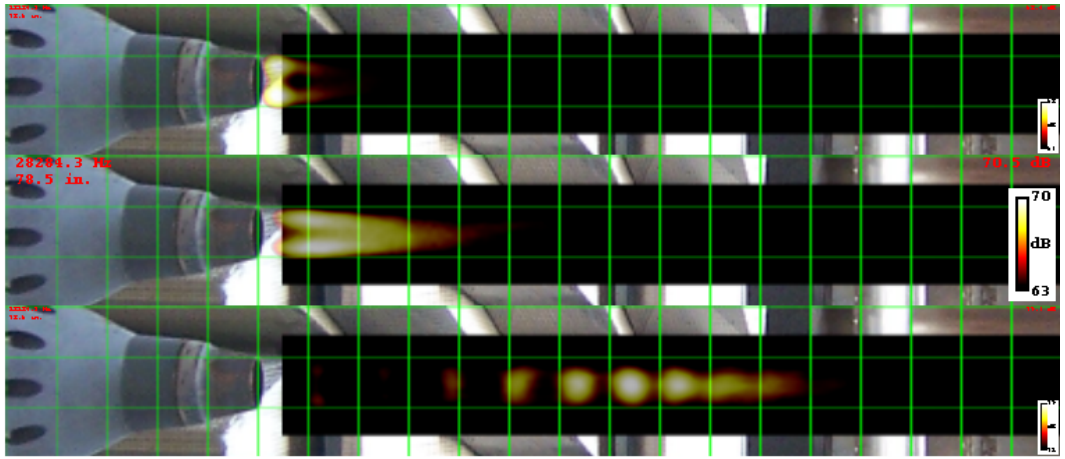

Mj=0.55 Hot
Mj=0.9 Hot
Mj=1.4 Cold
DS Distance (noz diams)
15
10
5
0
10^3
10^4
Freq (Hz)

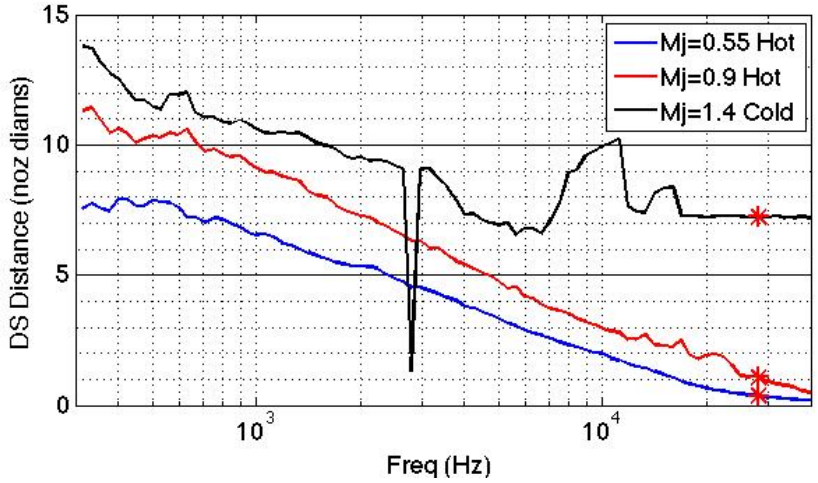

Mj=0.55 Hot
Mj=0.9 Hot
Mj=1.4 Cold
1/12th OB Array Median SPL (dB)
120
110
100
90
80
70
10^3
10^4

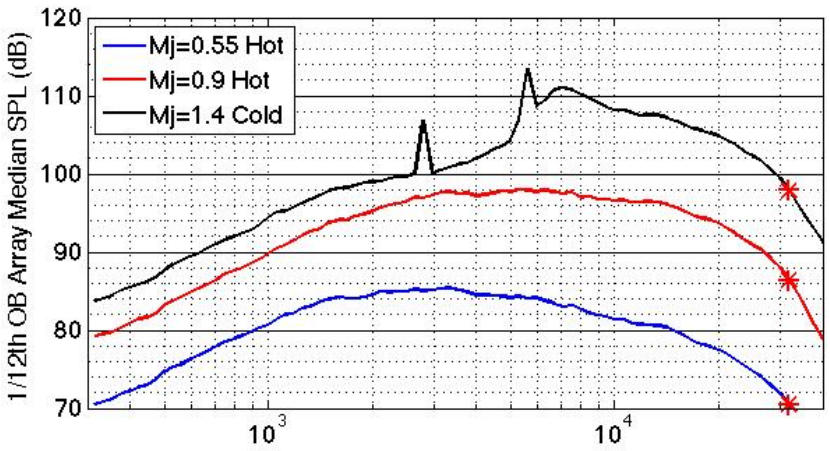

23043.5 Hz
78.5 in.
74.6 dB
74
dB
67

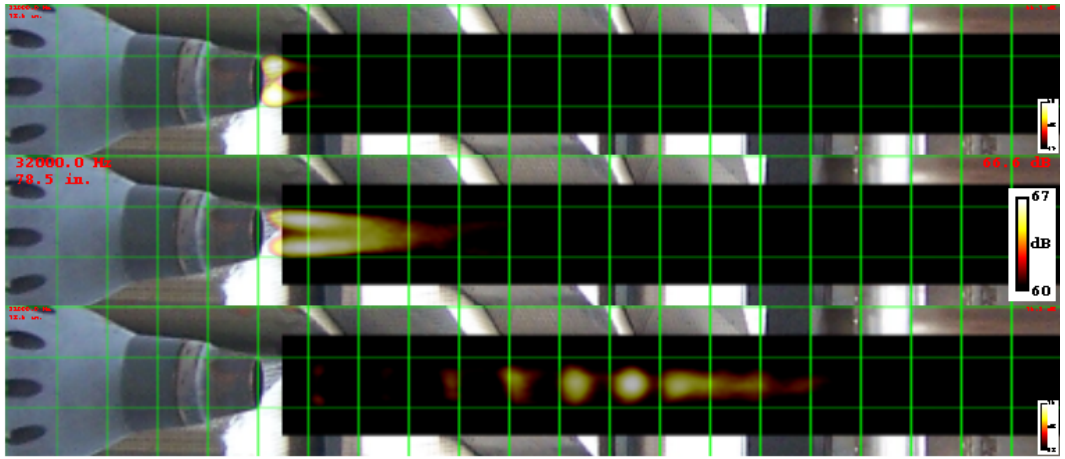

Mj=0.55 Hot
Mj=0.9 Hot
Mj=1.4 Cold
DS Distance (noz diams)
15
10
5
0
10^3
10^4
Freq (Hz)

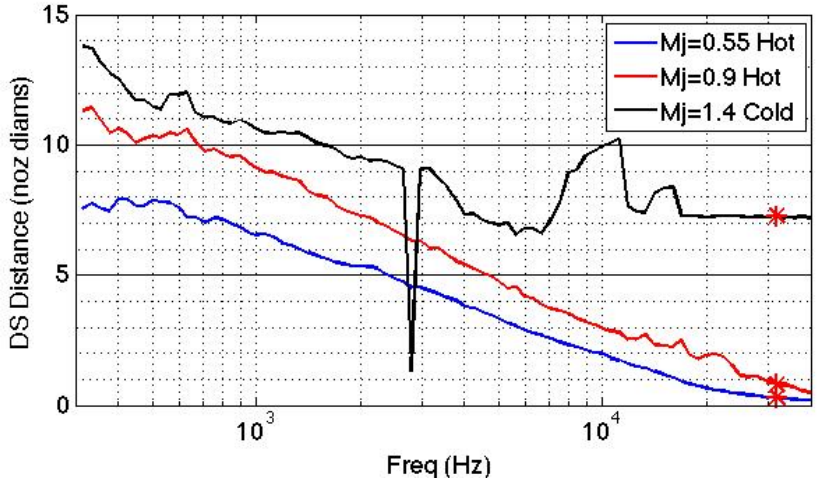

Mj=0.55 Hot
Mj=0.9 Hot
Mj=1.4 Cold
1/12th OB Array Median SPL (dB)
120
110
100
90
80
70
10^3
10^4


28204.3 Hz
78.5 in.
70.5 dB
70
dB
63

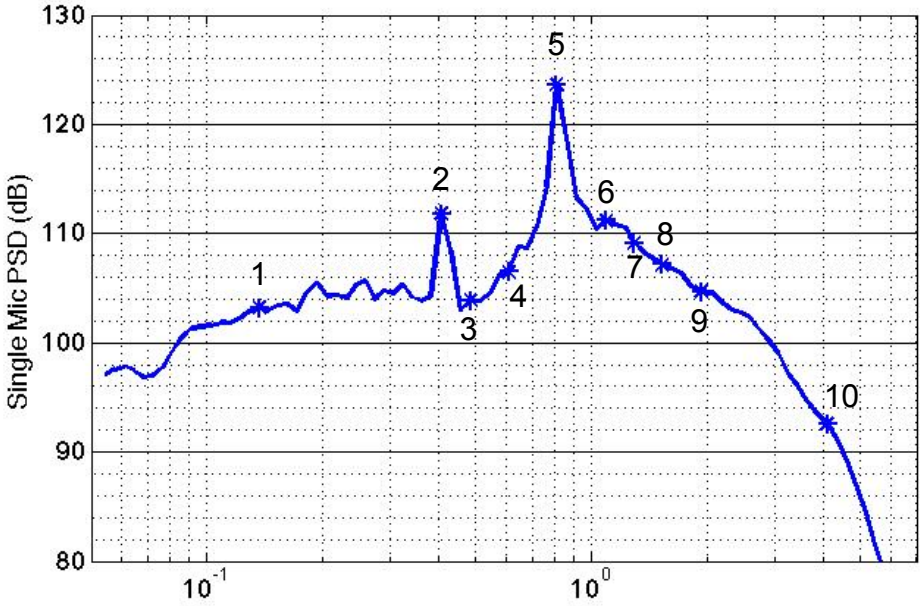

Mj=0.55 Hot
Mj=0.9 Hot
Mj=1.4 Cold
DS Distance (noz diams)
15
10
5
0
10^3
10^4
Freq (Hz)

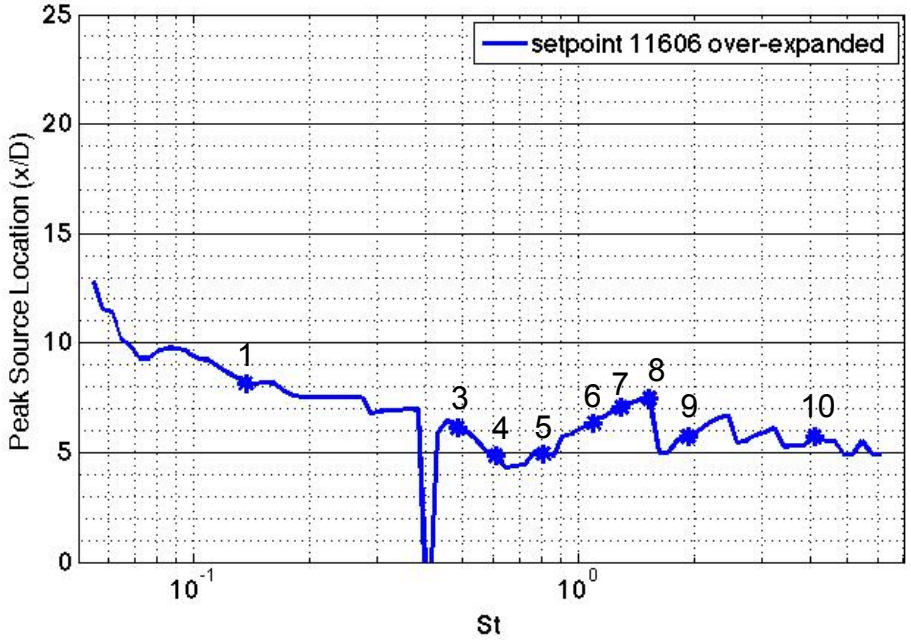

Mj=0.55 Hot
Mj=0.9 Hot
Mj=1.4 Cold
1/12th OB Array Median SPL (dB)
120
110
100
90
80
70
10^3
10^4

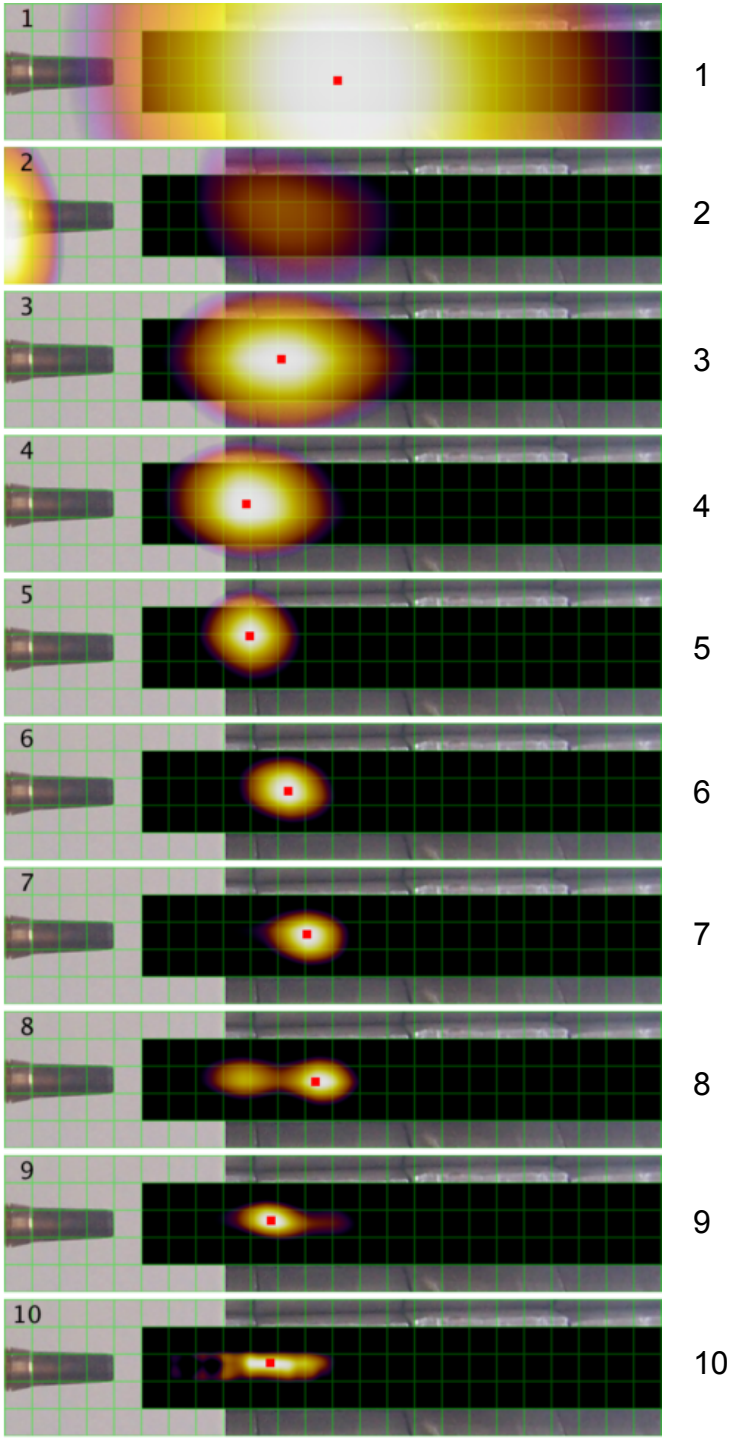

32000.0 Hz
78.5 in.
67
dB
60


Mj=0.55 Hot
Mj=0.9 Hot
Mj=1.4 Cold
DS Distance (noz diams)
15
10
5
0
10^3
10^4
Freq (Hz)

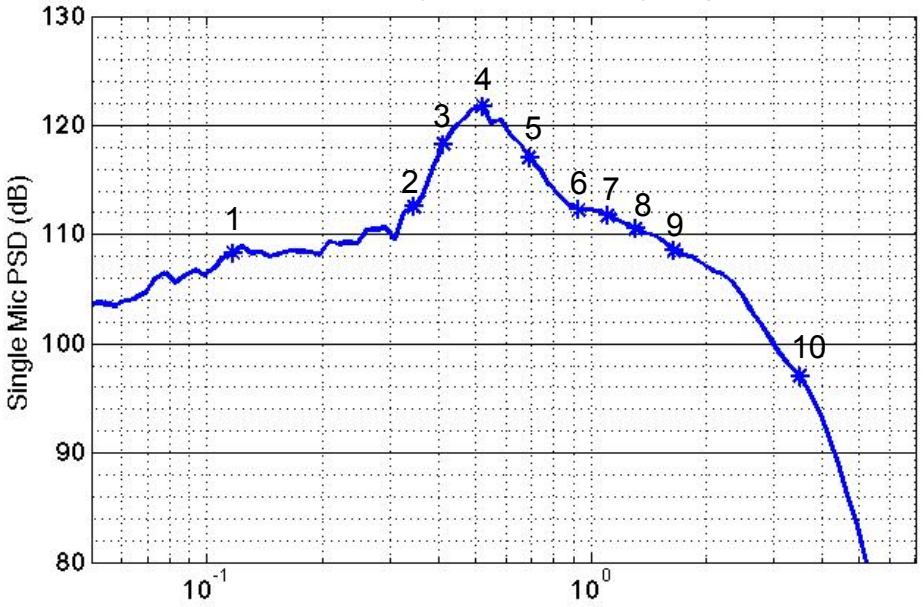
SMC016 M_j=1.29 $M_{jdesign}$=1.50

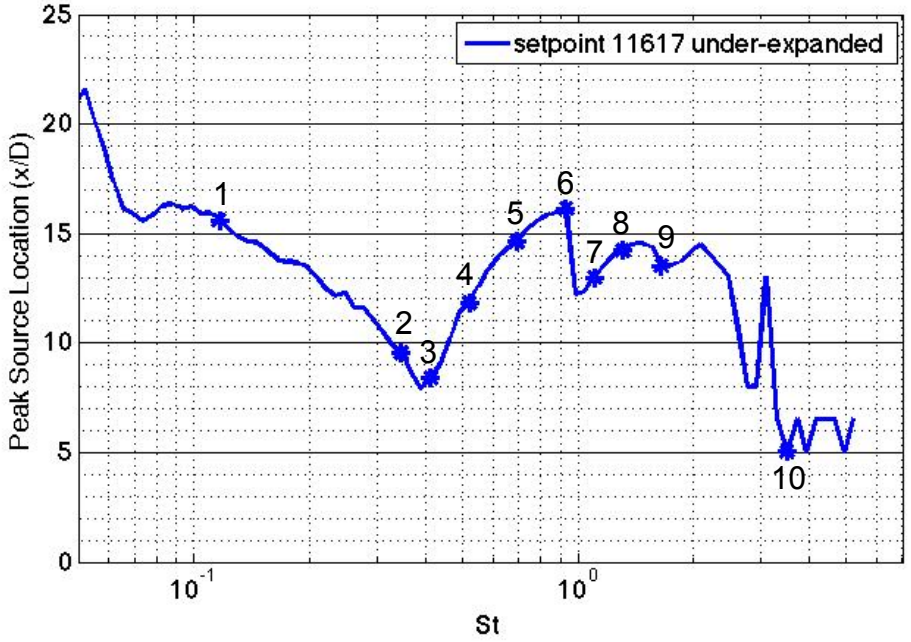


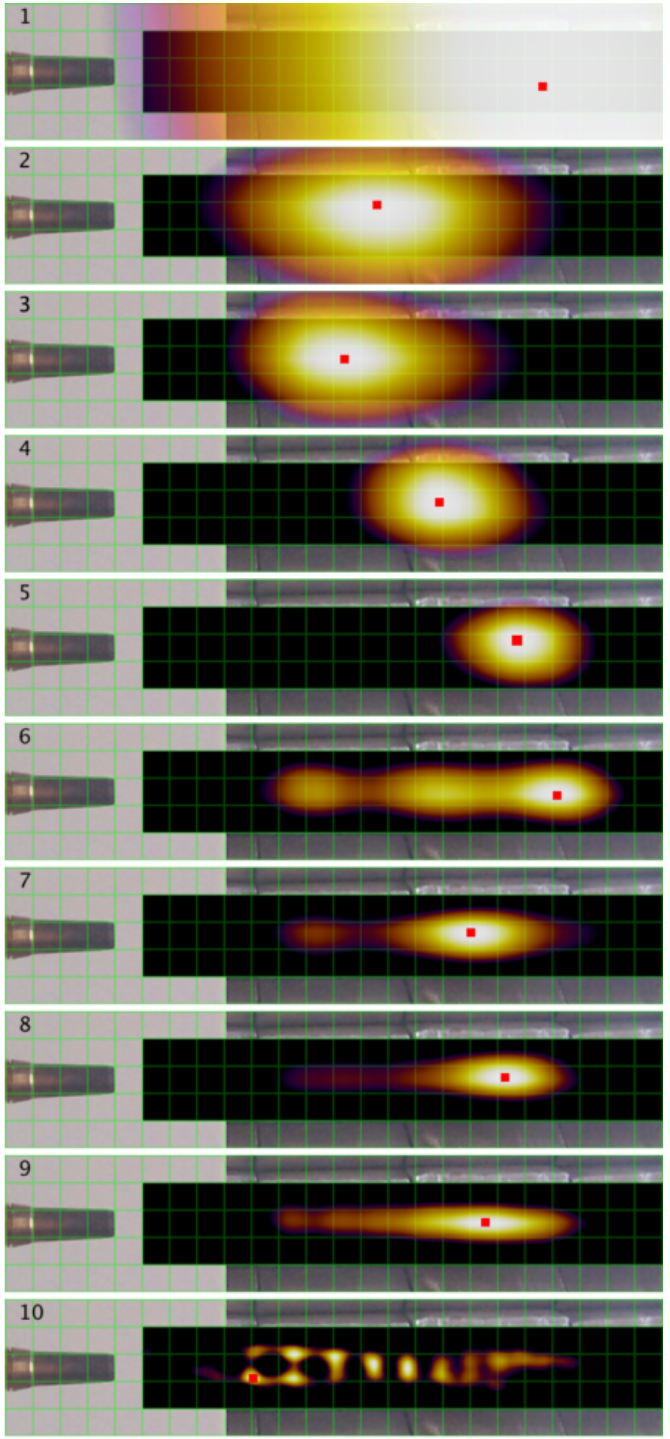


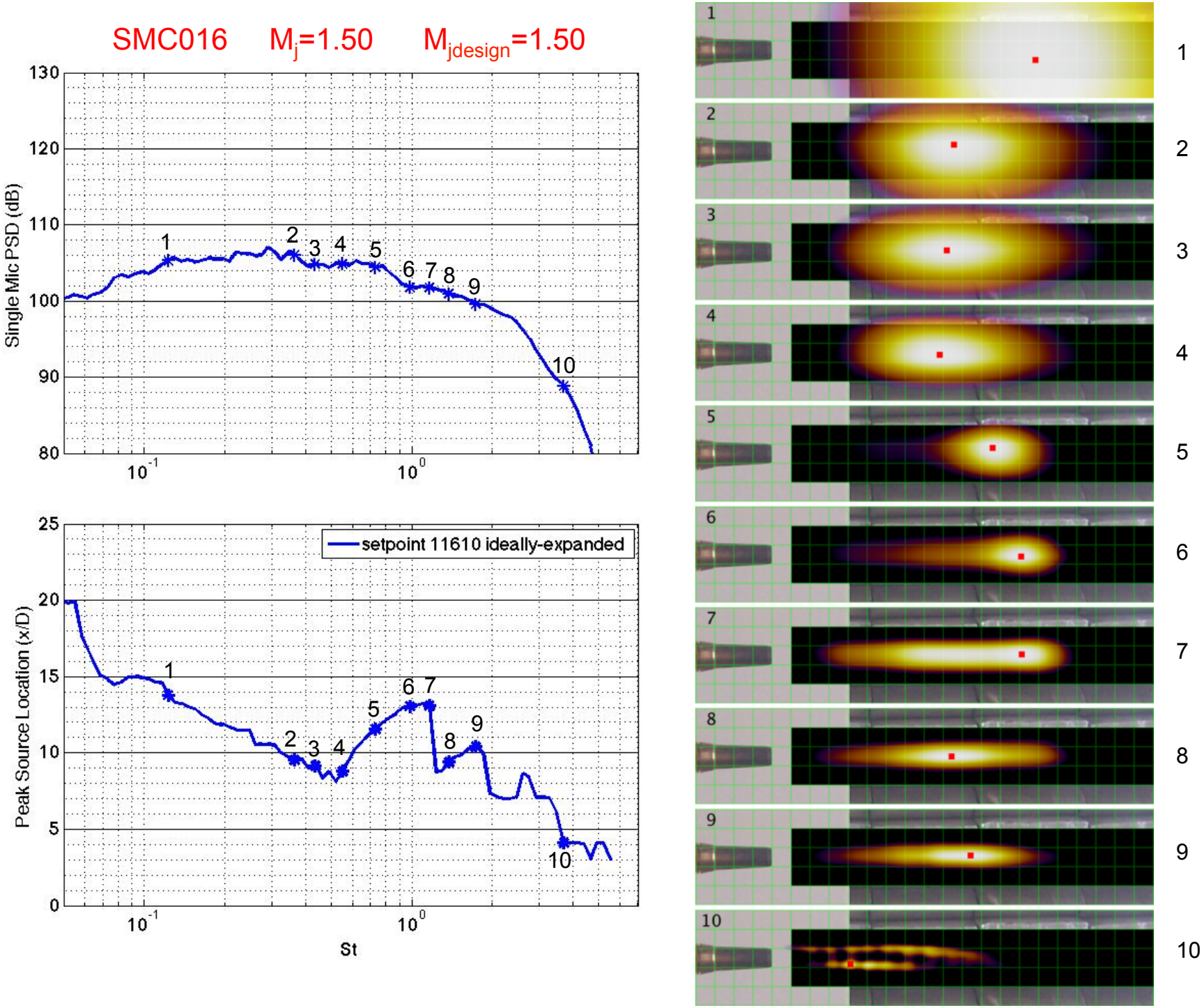


SMC016 M_j=1.61 $M_{jdesign}$=1.50








SMC016 M_j=1.50 $M_{jdesign}$=1.50
Single Mic PSD (dB)
130
120
110
100
90
80
10^{-1}
10^{0}
1
2
3
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5
6
7
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9
10
Peak Source Location (x/D)
25
20
15
10
5
0
St
setpoint 11610 ideally-expanded

Tam's Model of BBSN

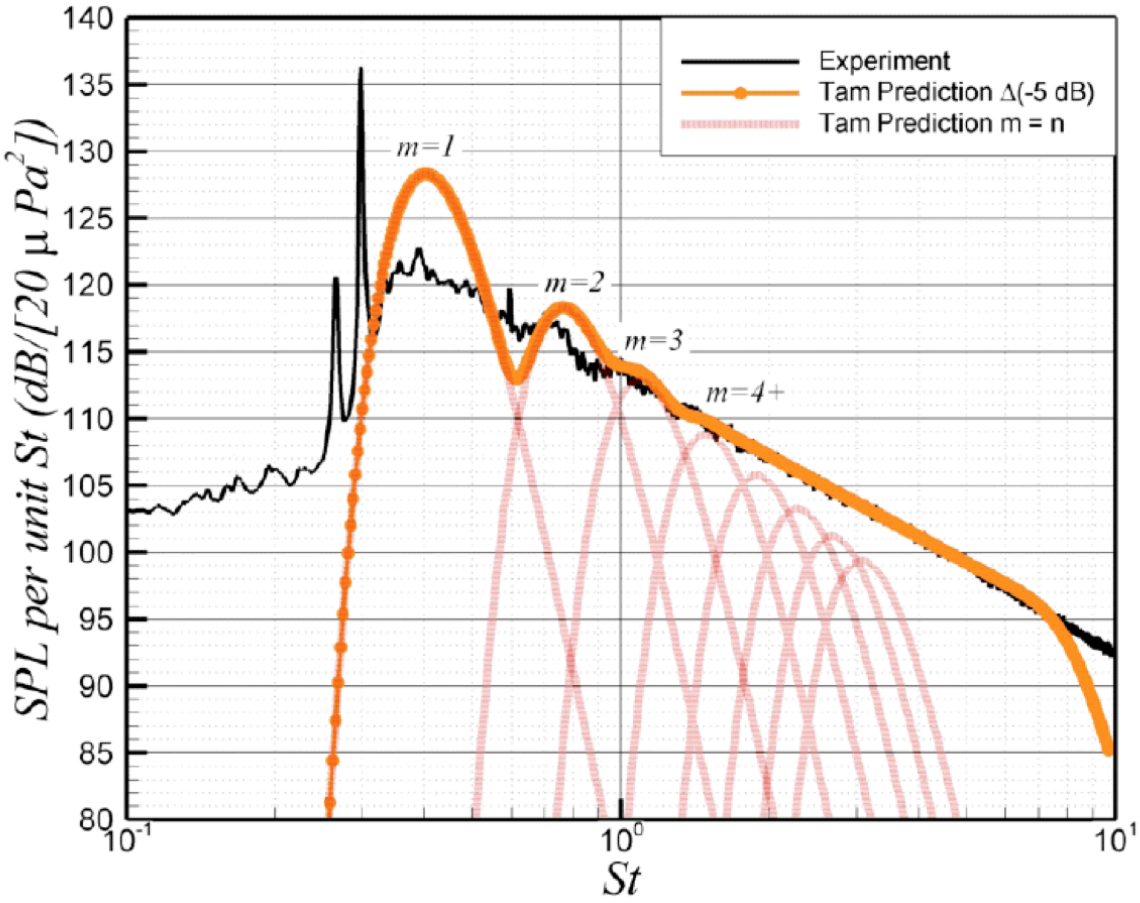


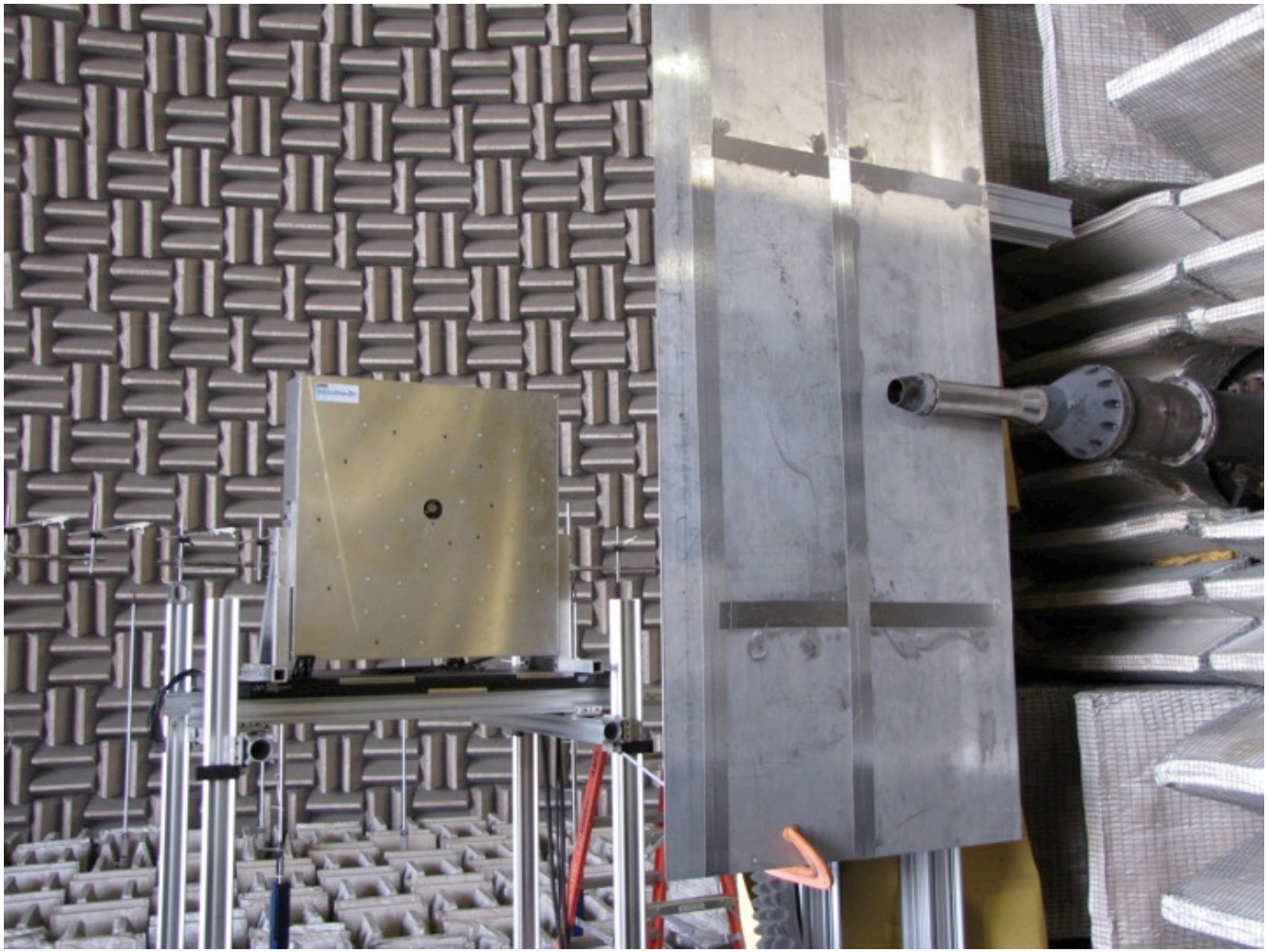
figure taken from Miller, S.A.E., "The Prediction of Broadband Shock-Associated Noise Using Reynolds-Averaged Navier-Stokes Solutions," Ph. D. dissertation, Pennsylvania State University, December 2009

Location of Array48 During JSIT

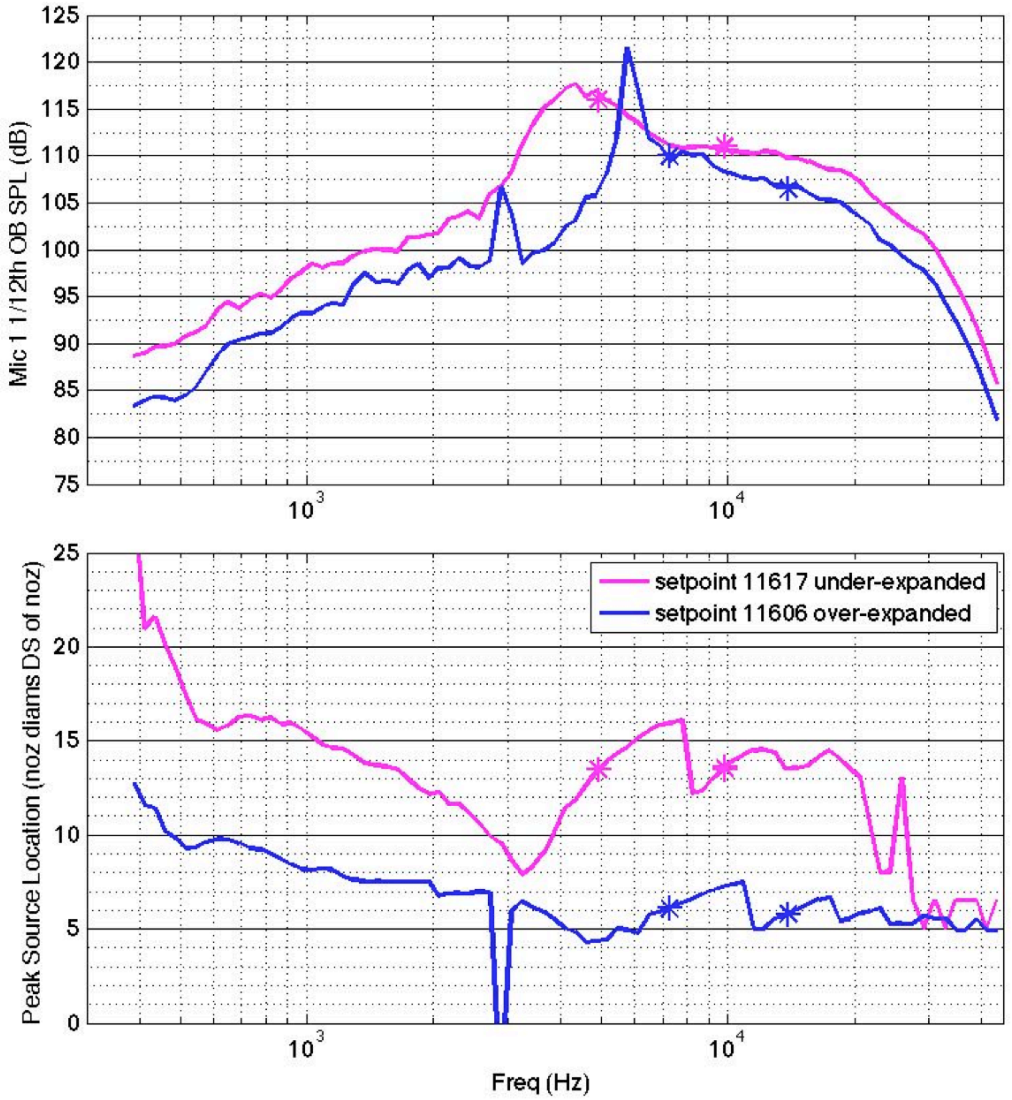
90° to jet axis

centered at nozzle exit

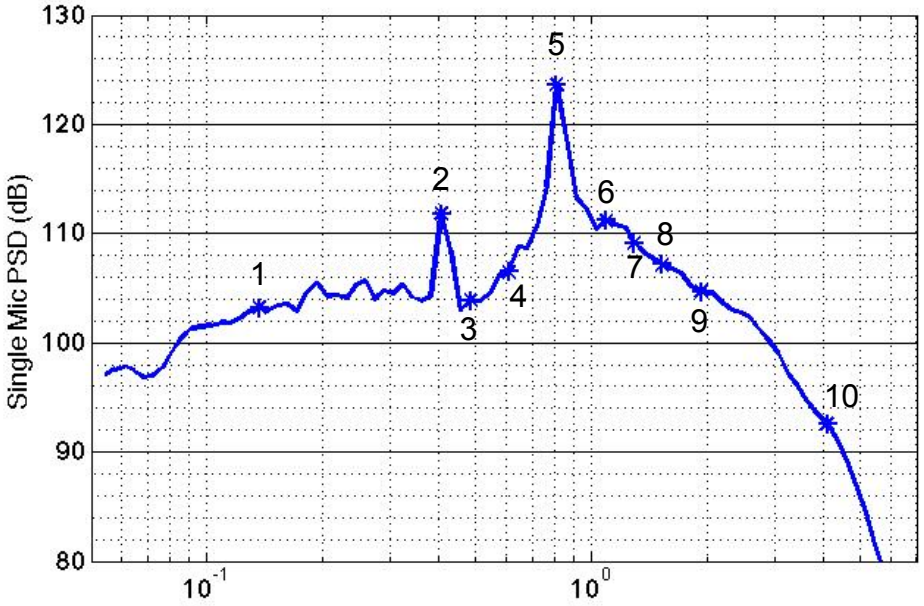
55 D away

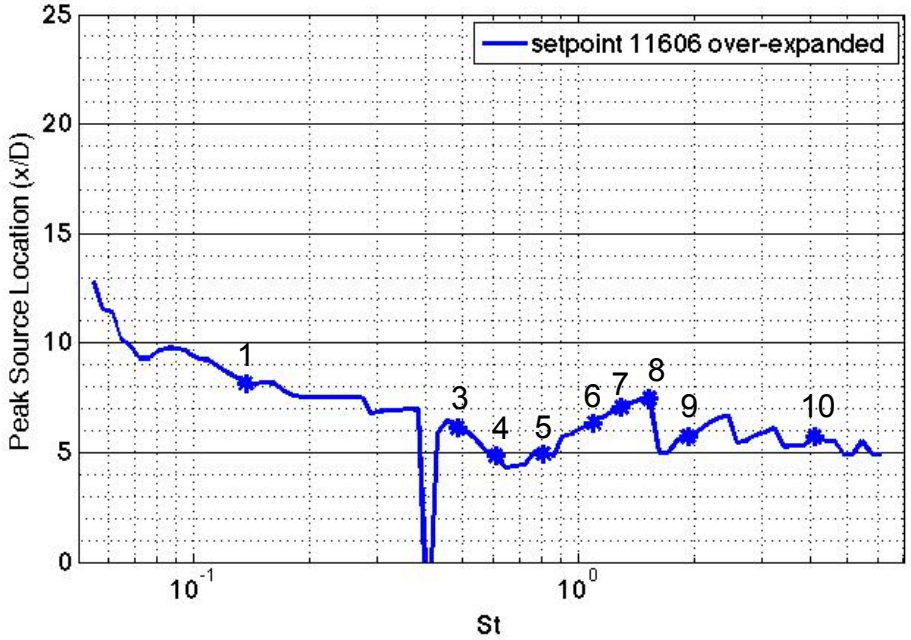


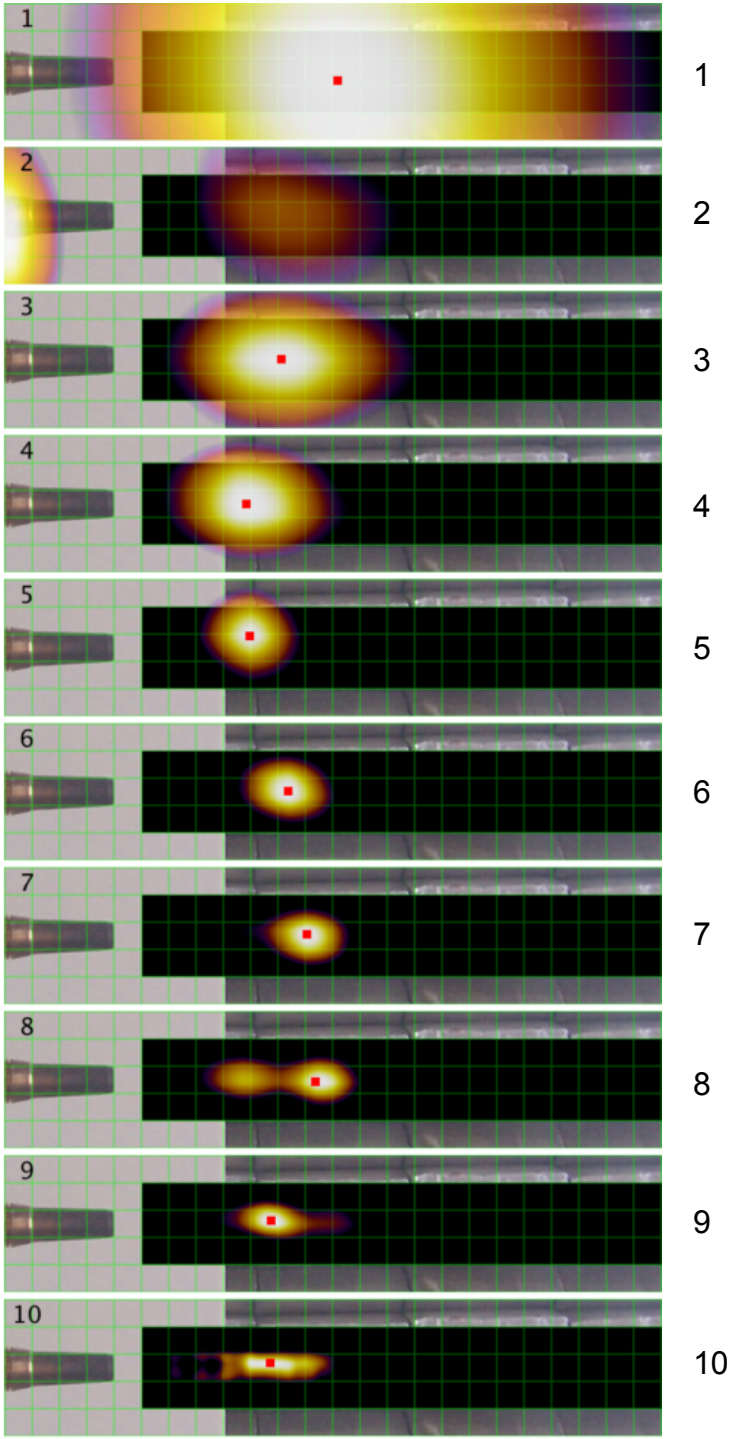
Peak Frequencies from Tam's Model Overlaid on Data

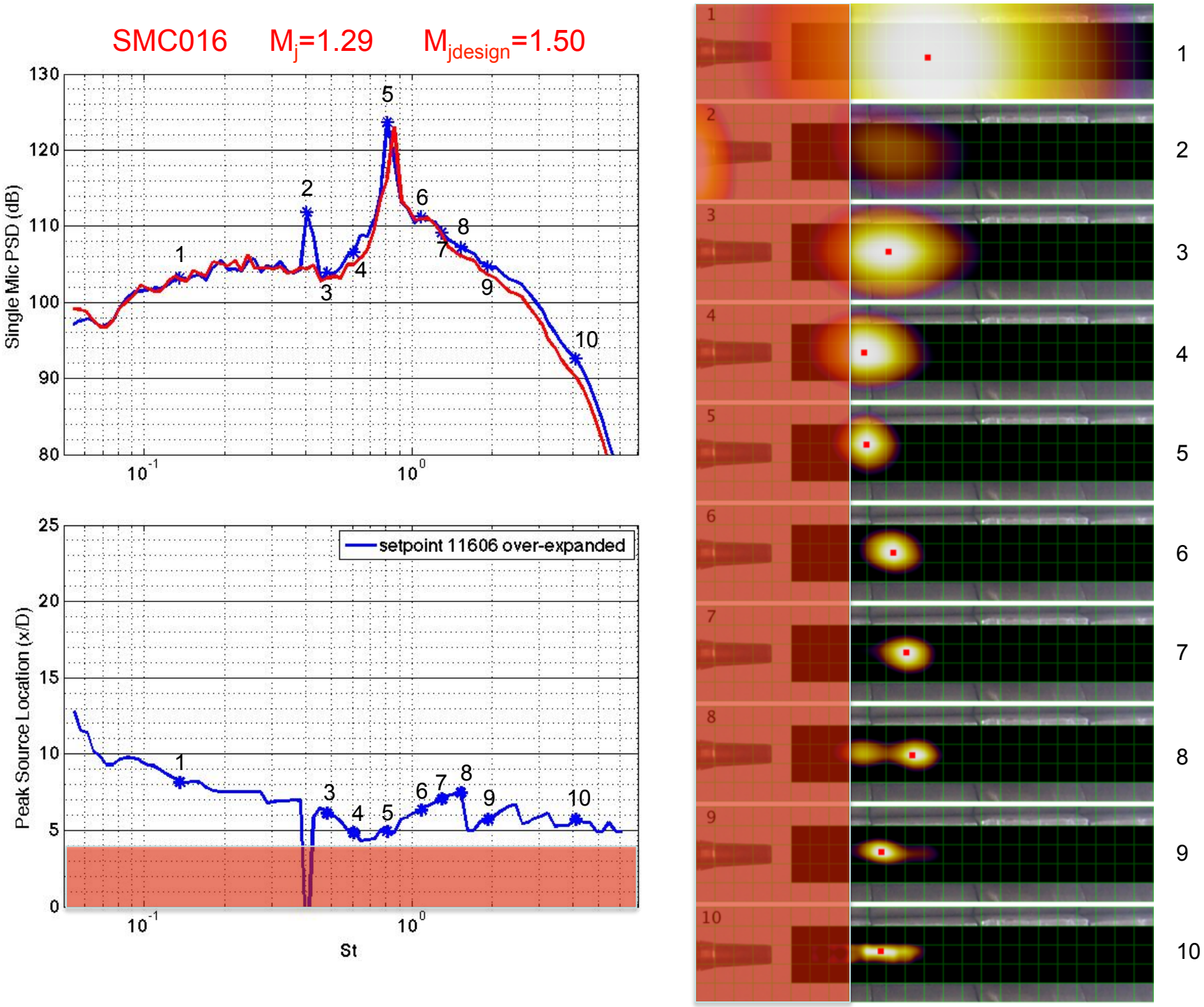


SMC016 M_j=1.29 $M_{jdesign}$=1.50








SMC016 M_j=1.29 $M_{jdesign}$=1.50
Single Mic PSD (dB)
130
120
110
100
90
80
10^{-1}
10^{0}
1
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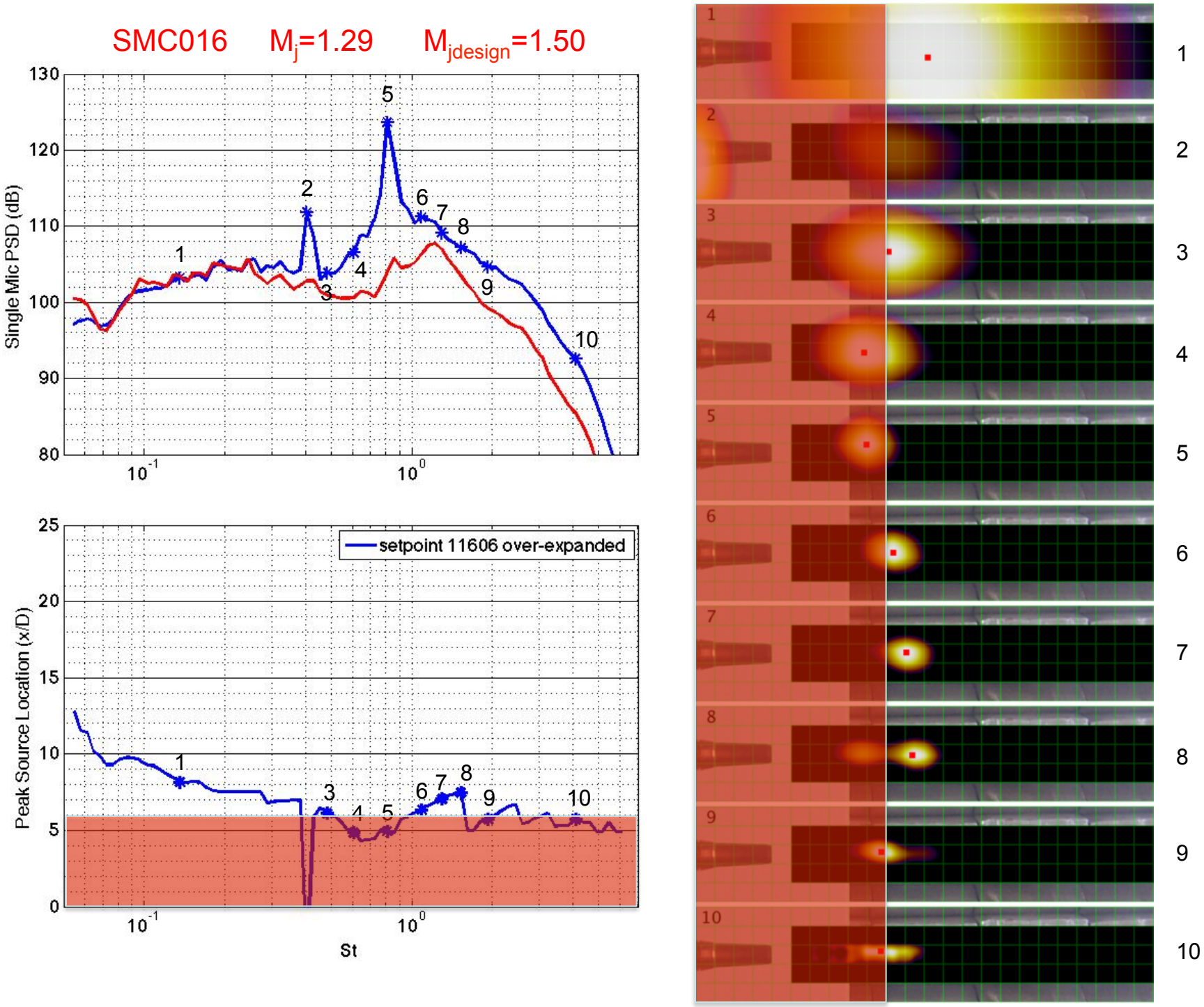
9
10
Peak Source Location (x/D)
25
20
15
10
5
0
setpoint 11606 over-expanded
St


SMC016 M_j=1.29 $M_{jdesign}$=1.50
Single Mic PSD (dB)
130
120
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100
90
80
10^{-1}
10^{0}
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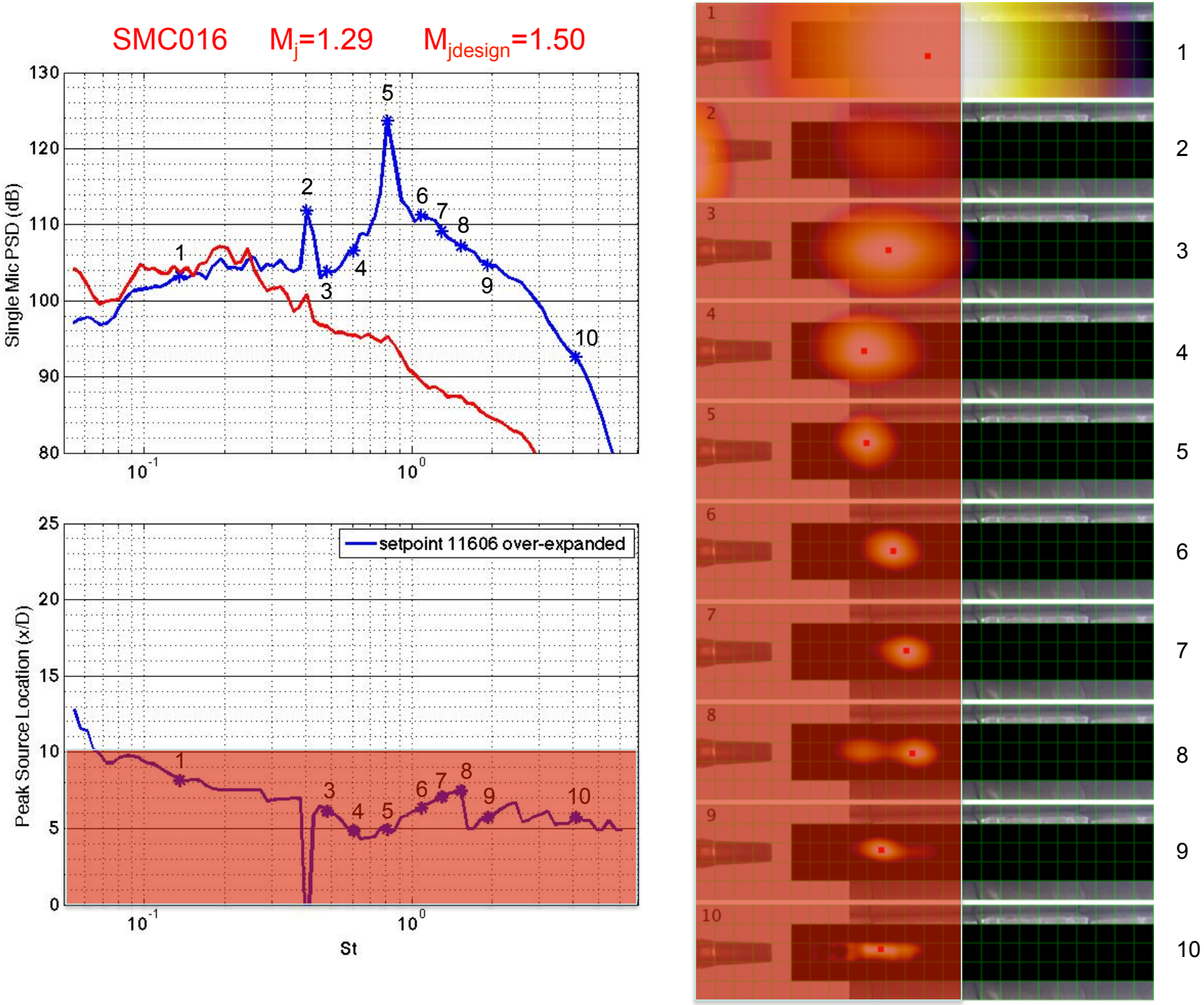
9
10
Peak Source Location (x/D)
25
20
15
10
5
0
setpoint 11606 over-expanded
St


SMC016 M_j=1.29 $M_{jdesign}$=1.50
Single Mic PSD (dB)
130
120
110
100
90
80
10^{-1}
10^{0}
1
2
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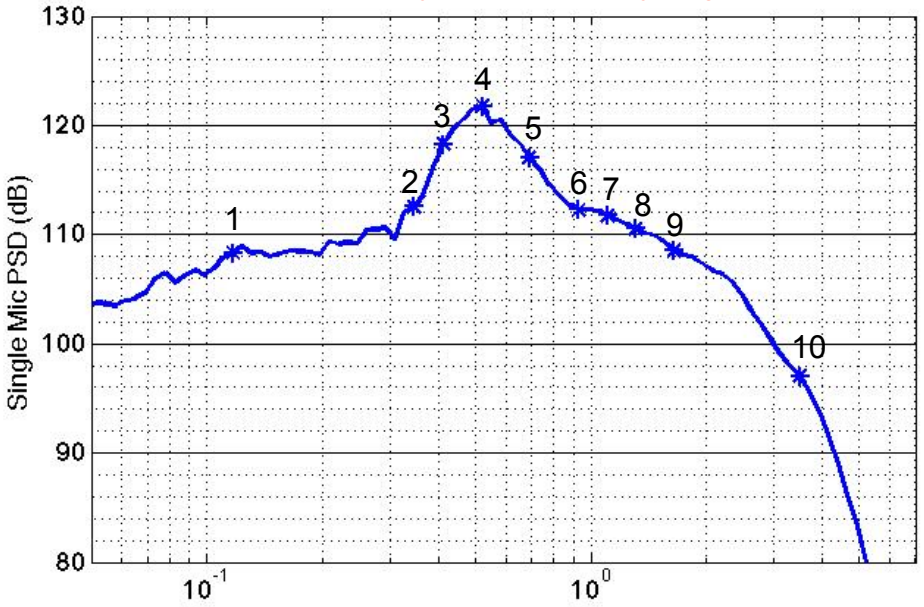
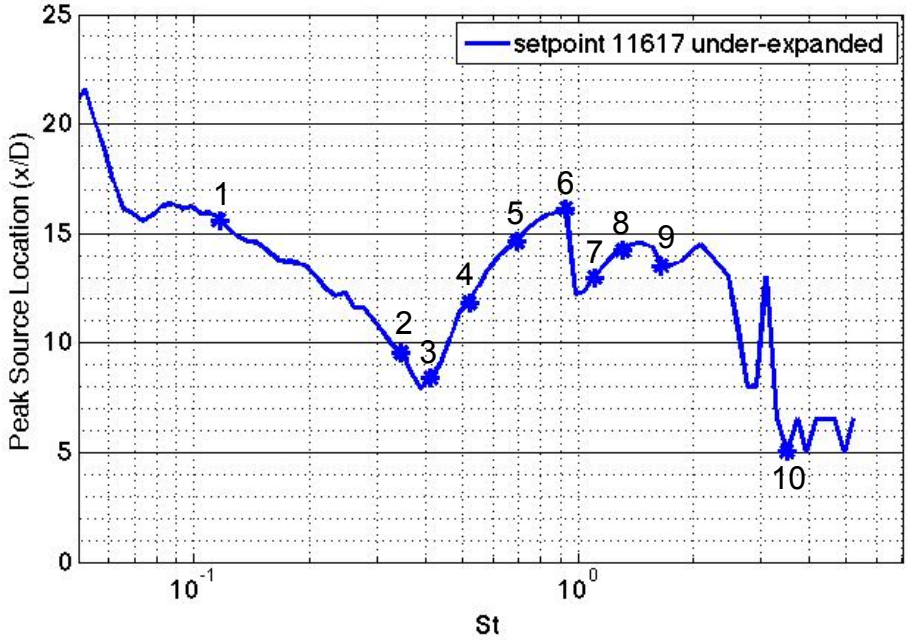
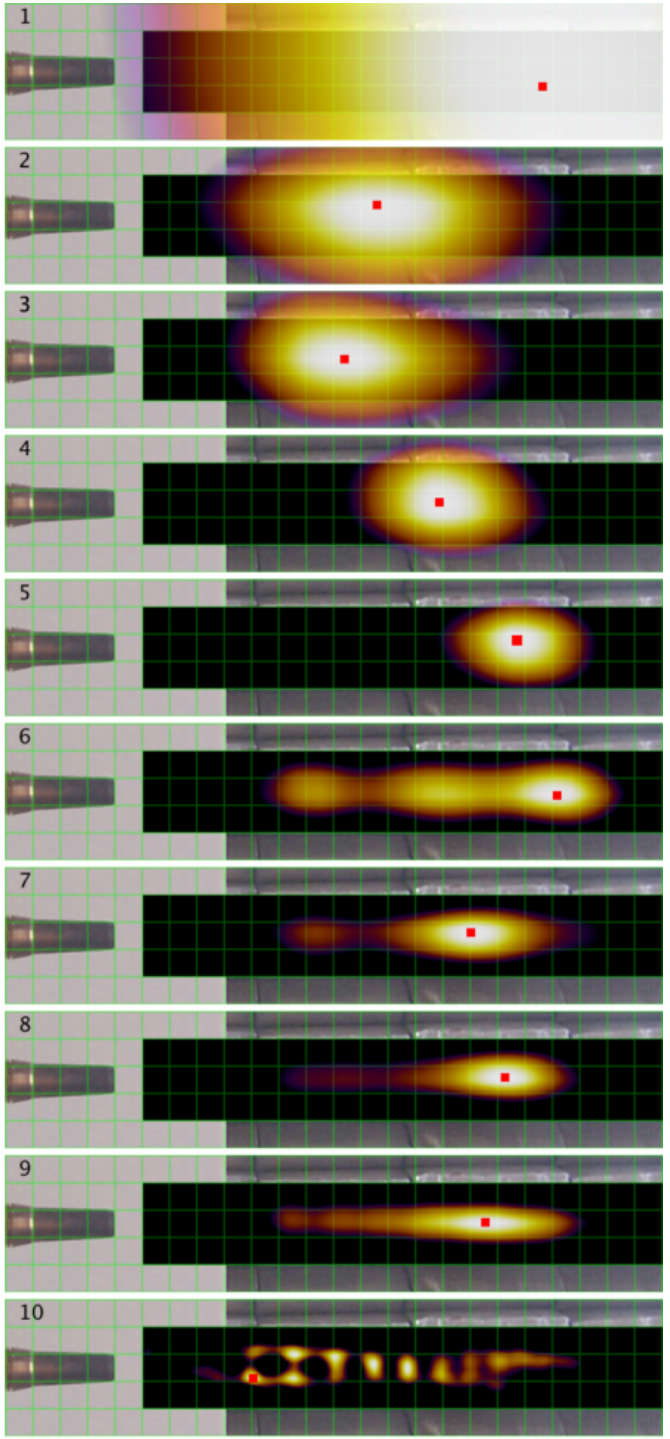
7
8
9
10
Peak Source Location (x/D)
25
20
15
10
5
0
setpoint 11606 over-expanded
St

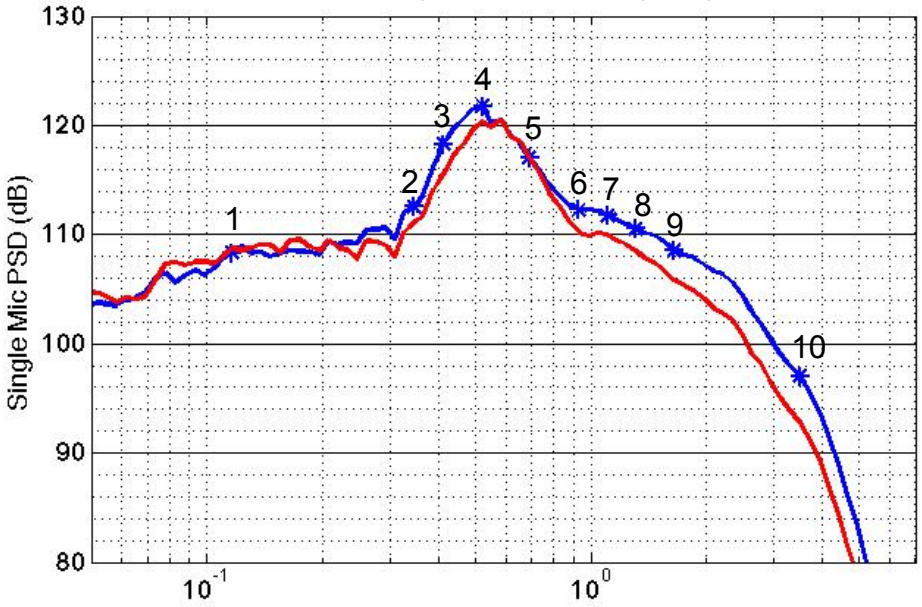
SMC016 M_j=1.61 $M_{jdesign}$=1.50

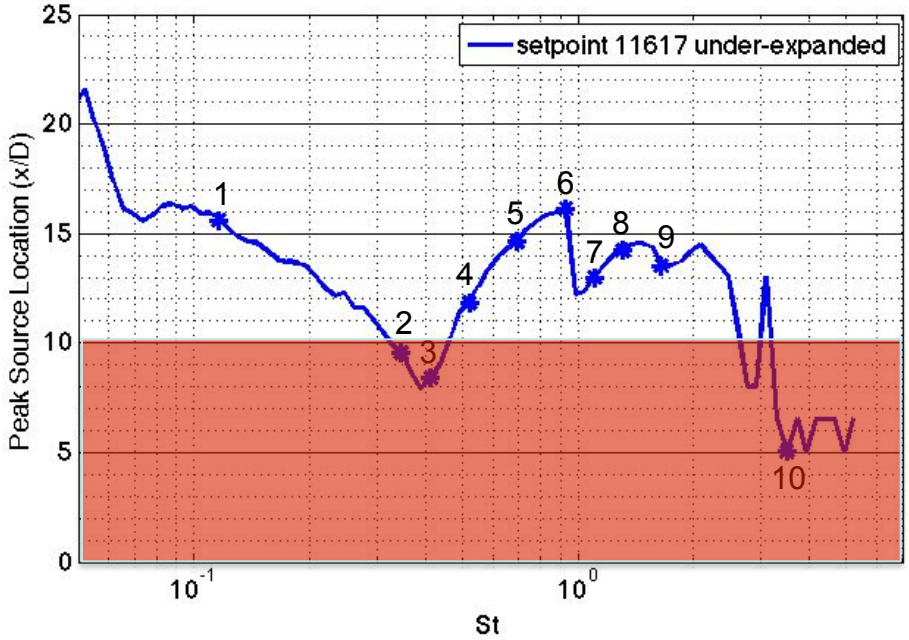


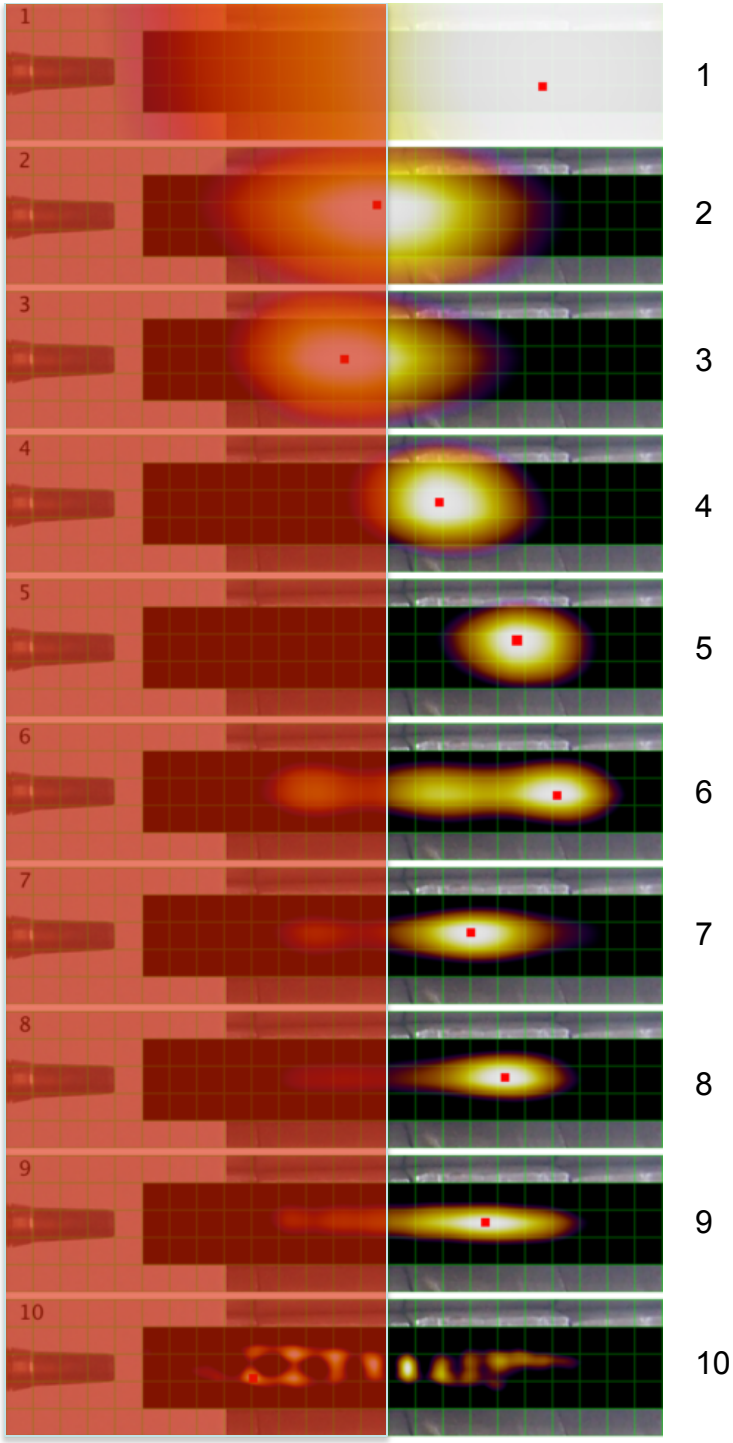


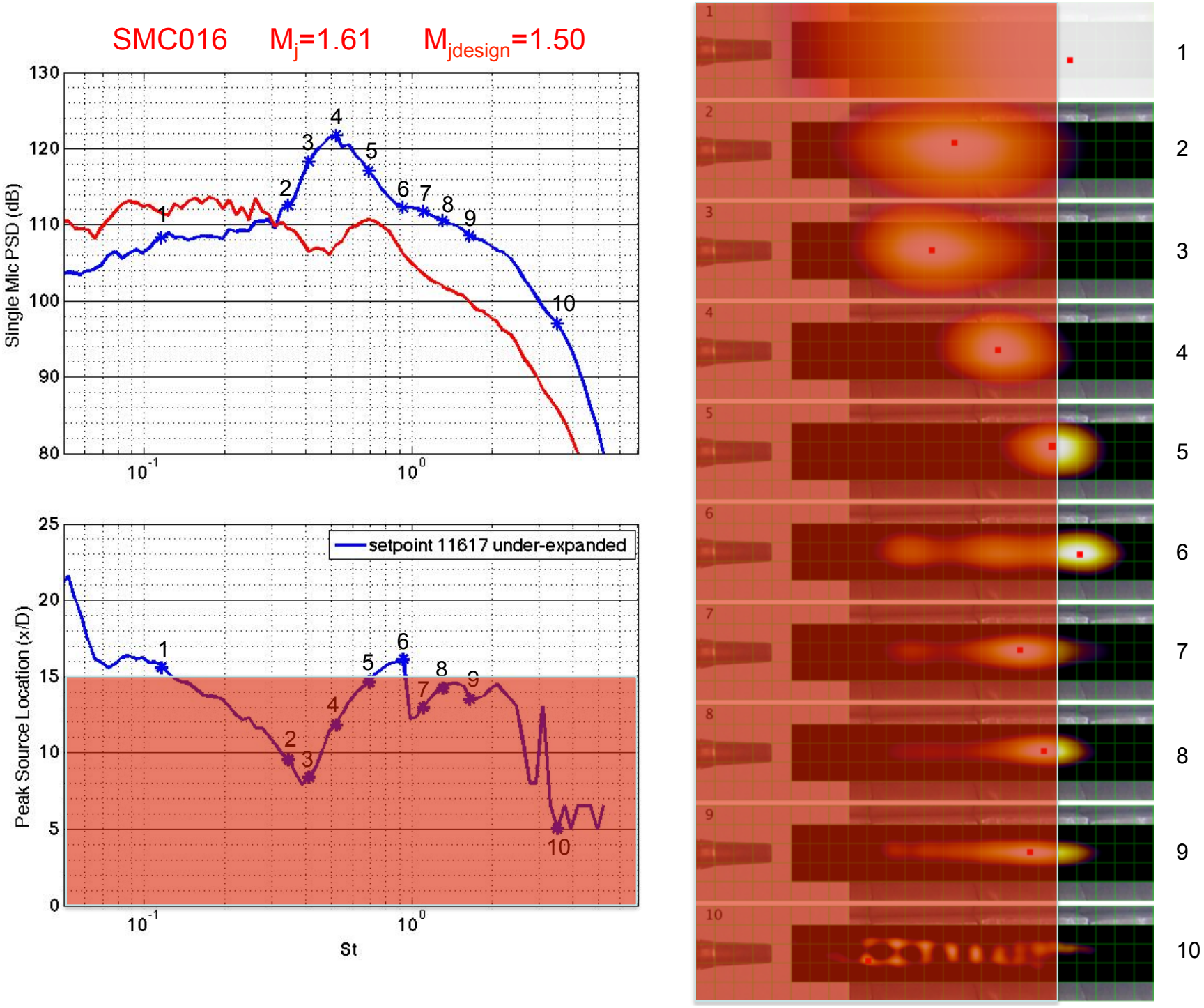


SMC016 M_j=1.61 $M_{jdesign}$=1.50








SMC016 M_j=1.61 $M_{jdesign}$=1.50
Single Mic PSD (dB)
130
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10^{-1}
10^{0}
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10
Peak Source Location (x/D)
25
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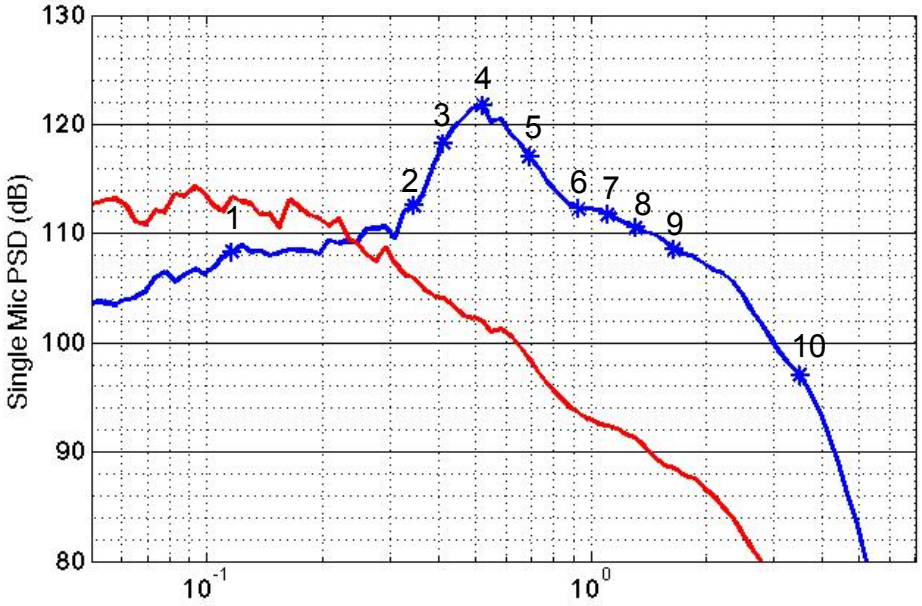
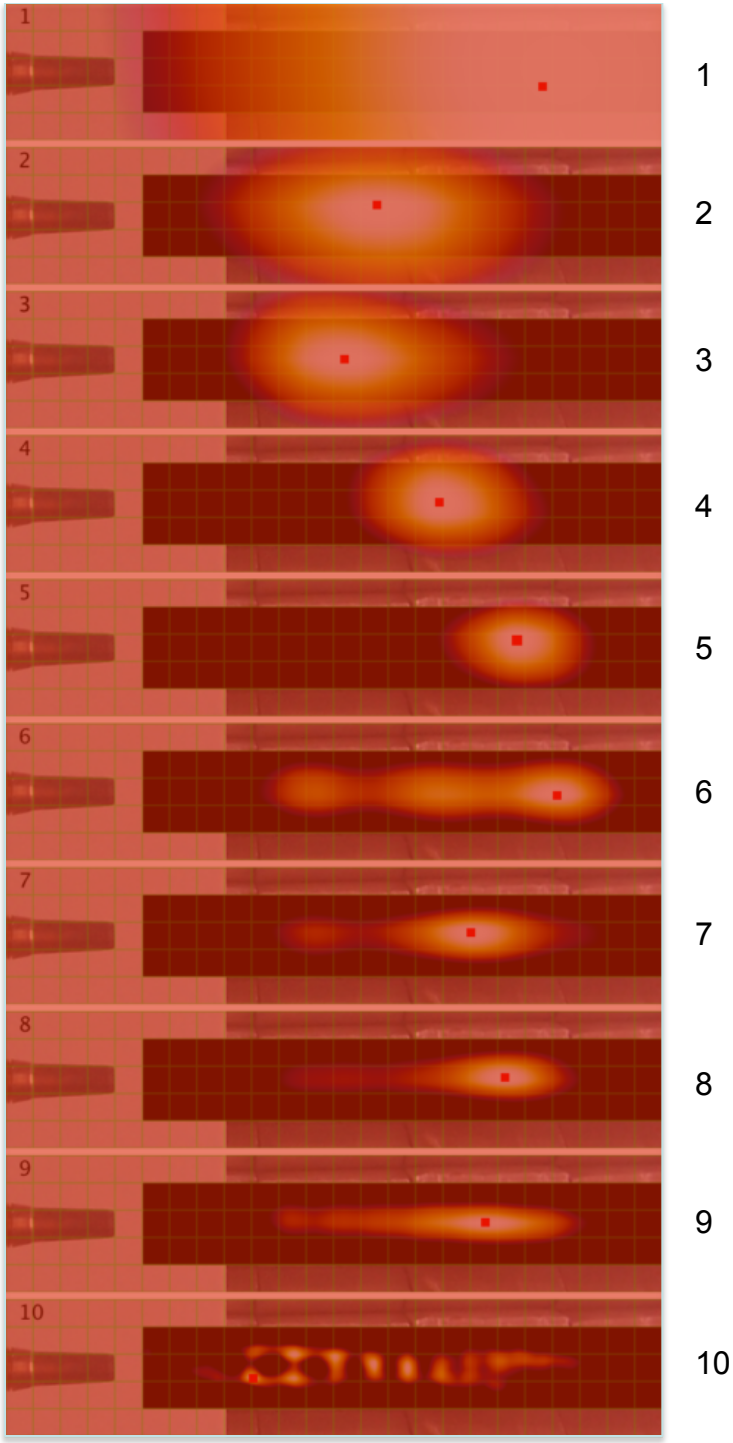
0
setpoint 11617 under-expanded
St

SMC016 M_j=1.61 $M_{jdesign}$=1.50





SMC016 convergent-divergent

under-expanded

set point 11606

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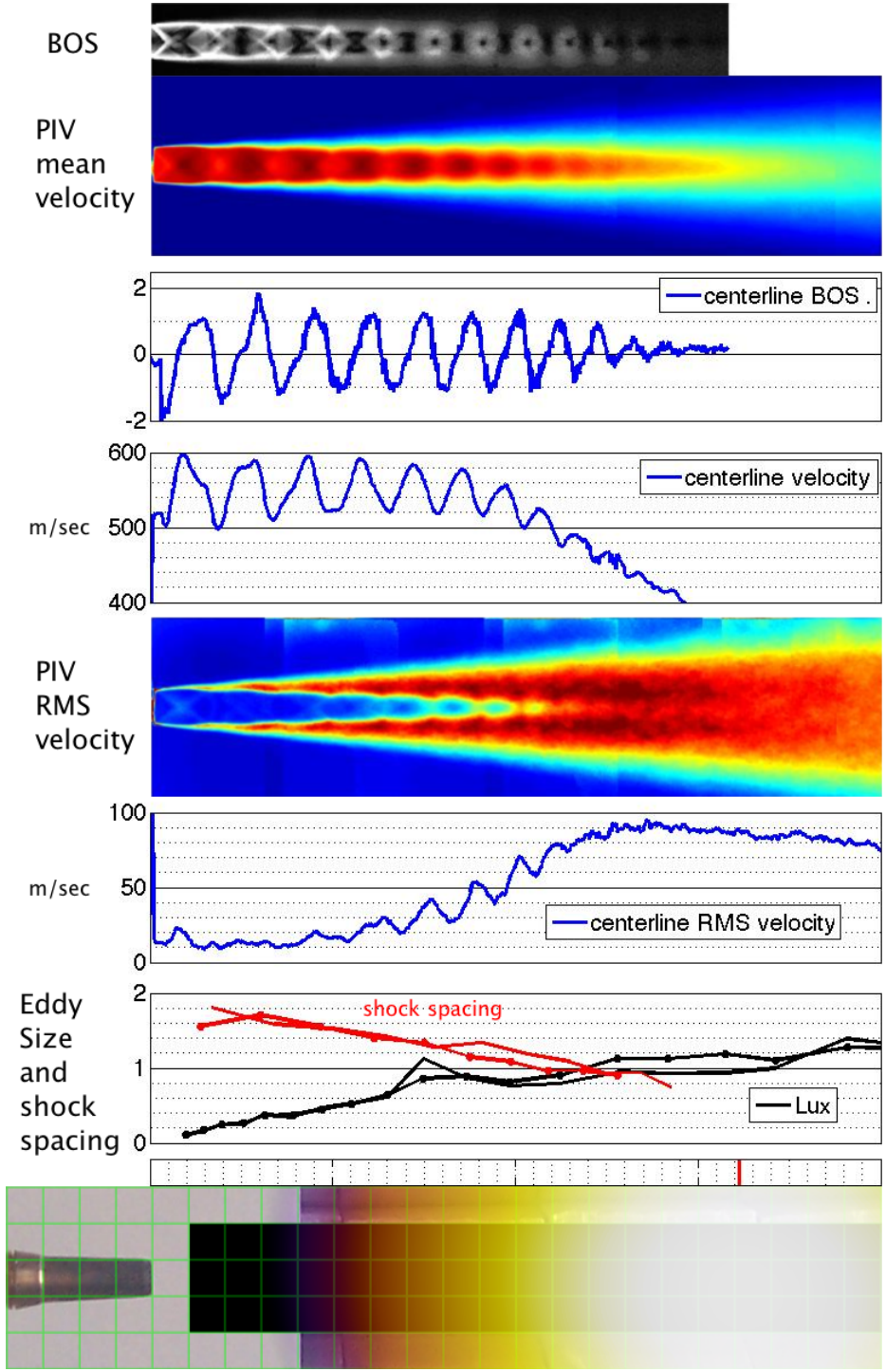
$M_{jdesign}$=1.50



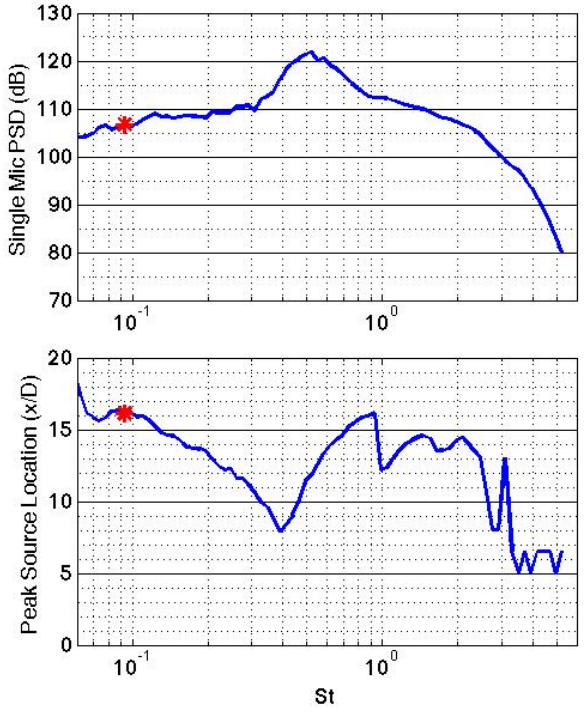
SMC016

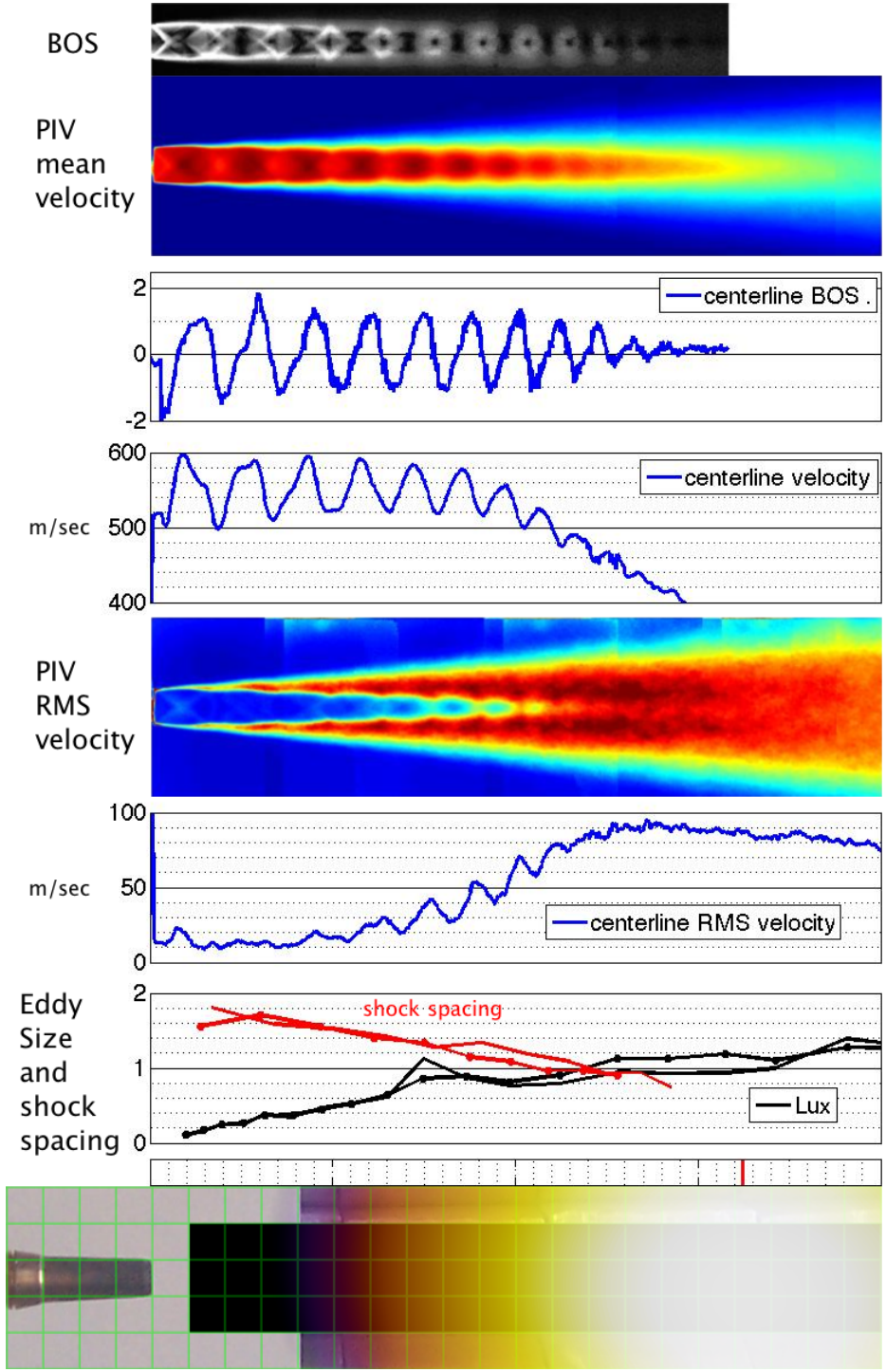
under-expanded

set pt 11617

Mj=1.61

Mjdesign=1.50





SMC016

under-expanded

set pt 11617

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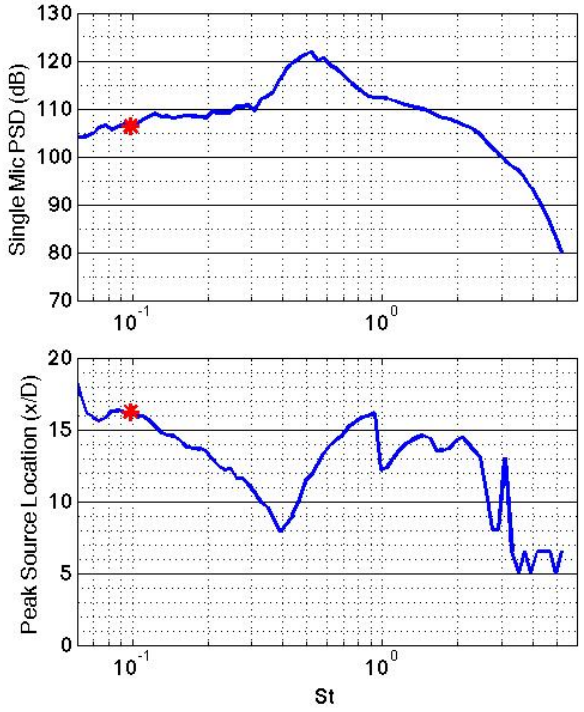
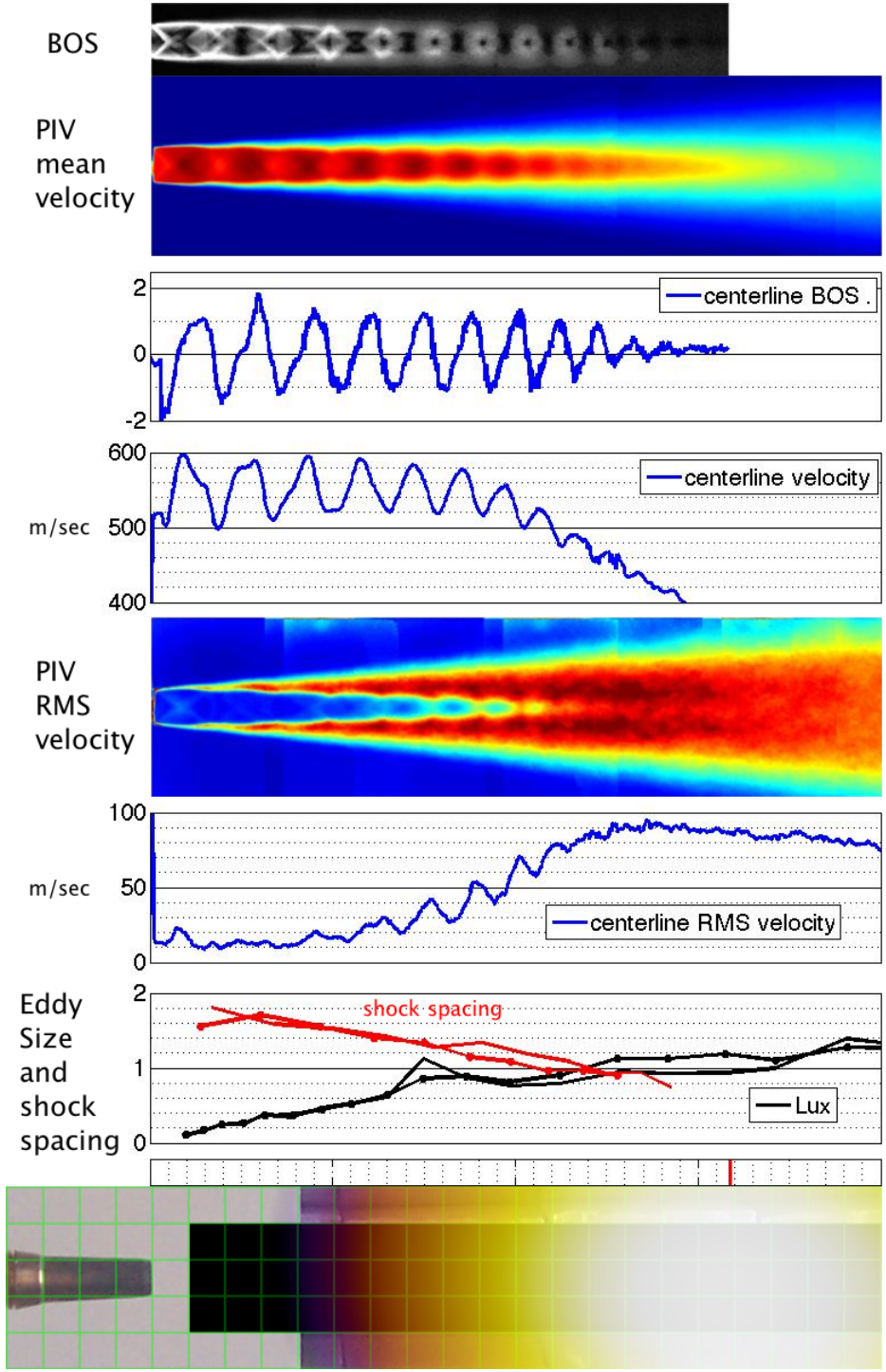
Mjdesign=1.50





SMC016

under-expanded

set pt 11617

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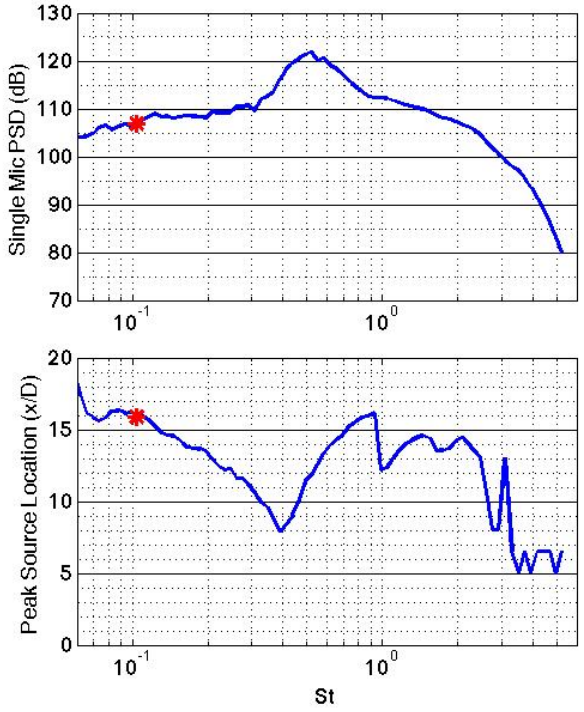
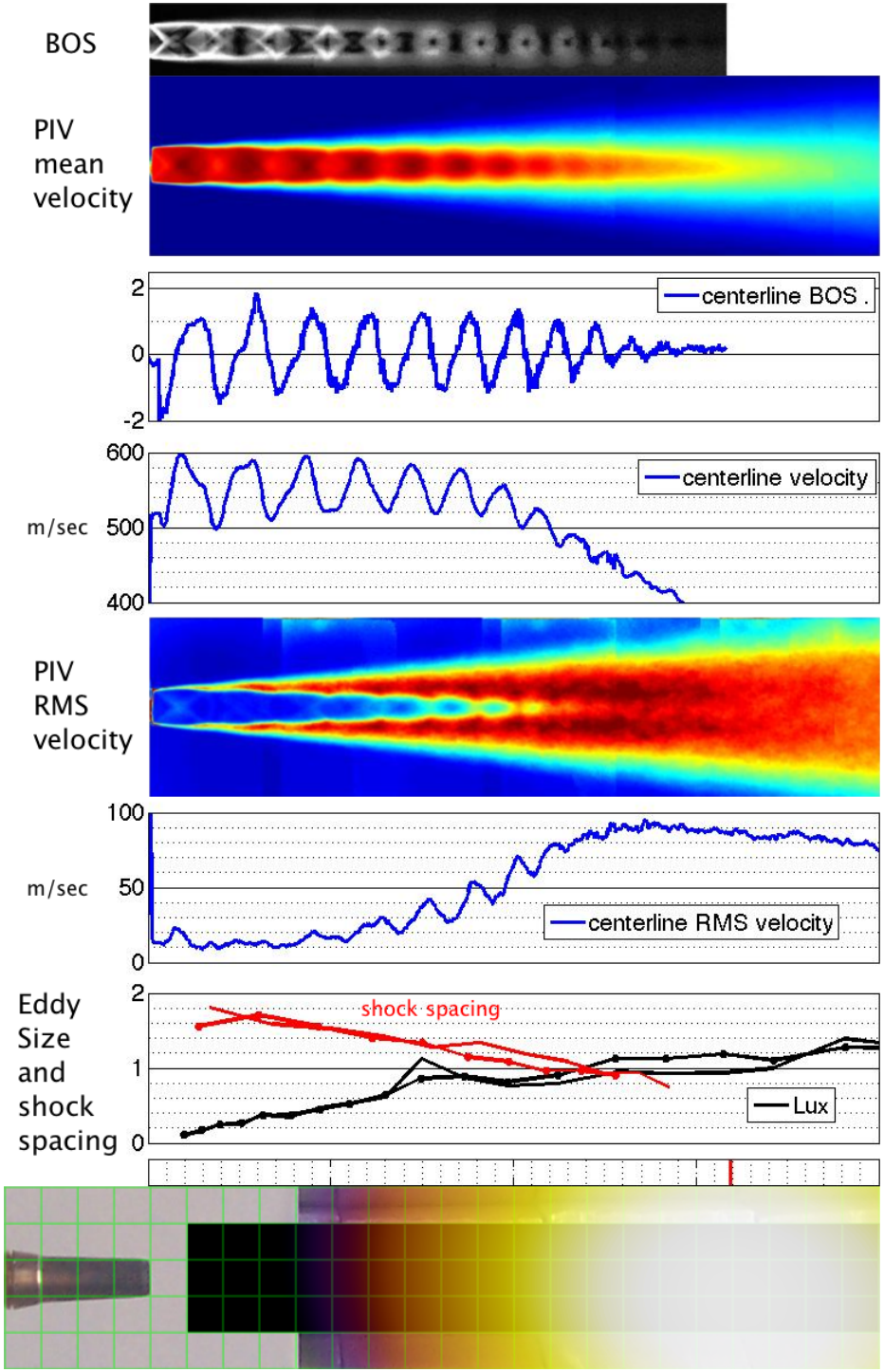
Mjdesign=1.50





SMC016

under-expanded

set pt 11617

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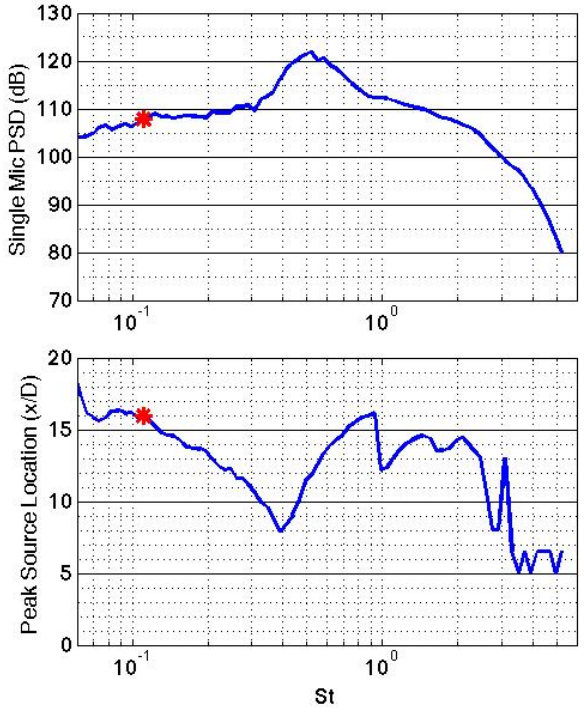
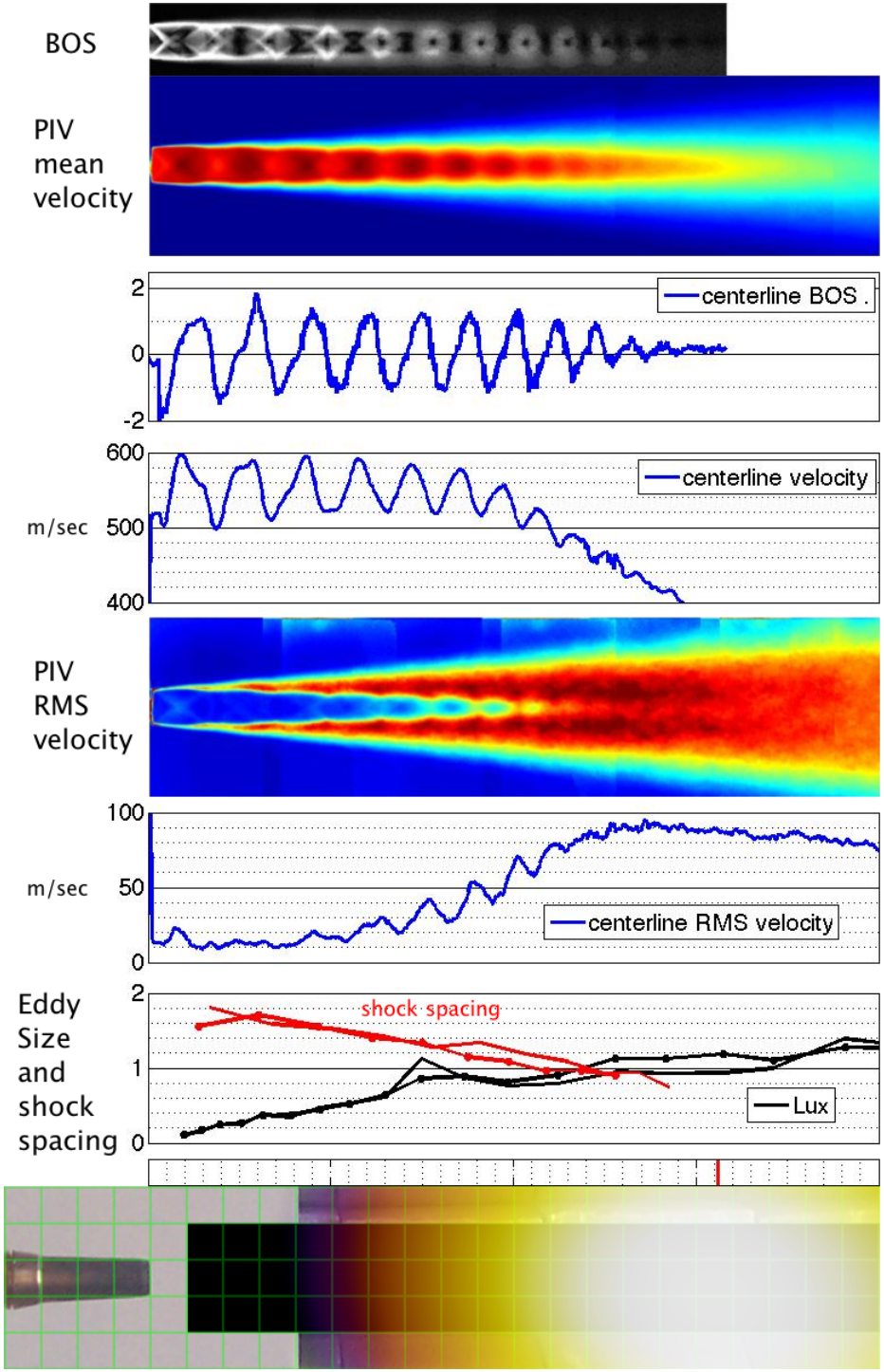
Mjdesign=1.50





SMC016

under-expanded

set pt 11617

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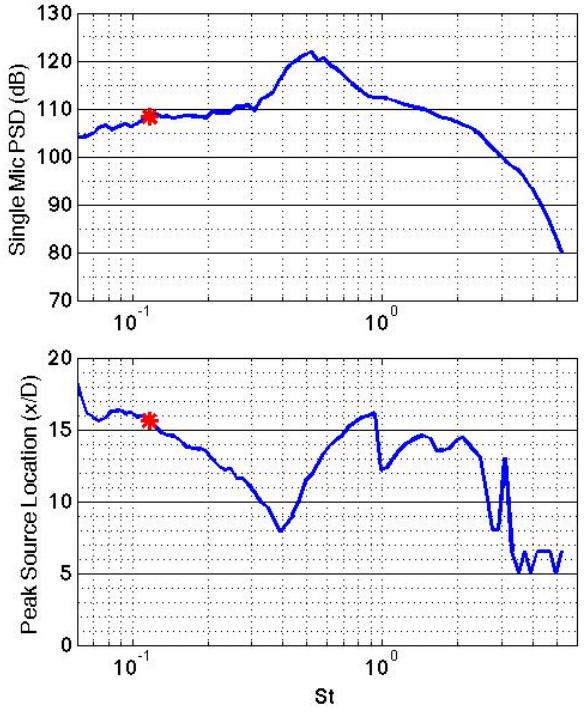
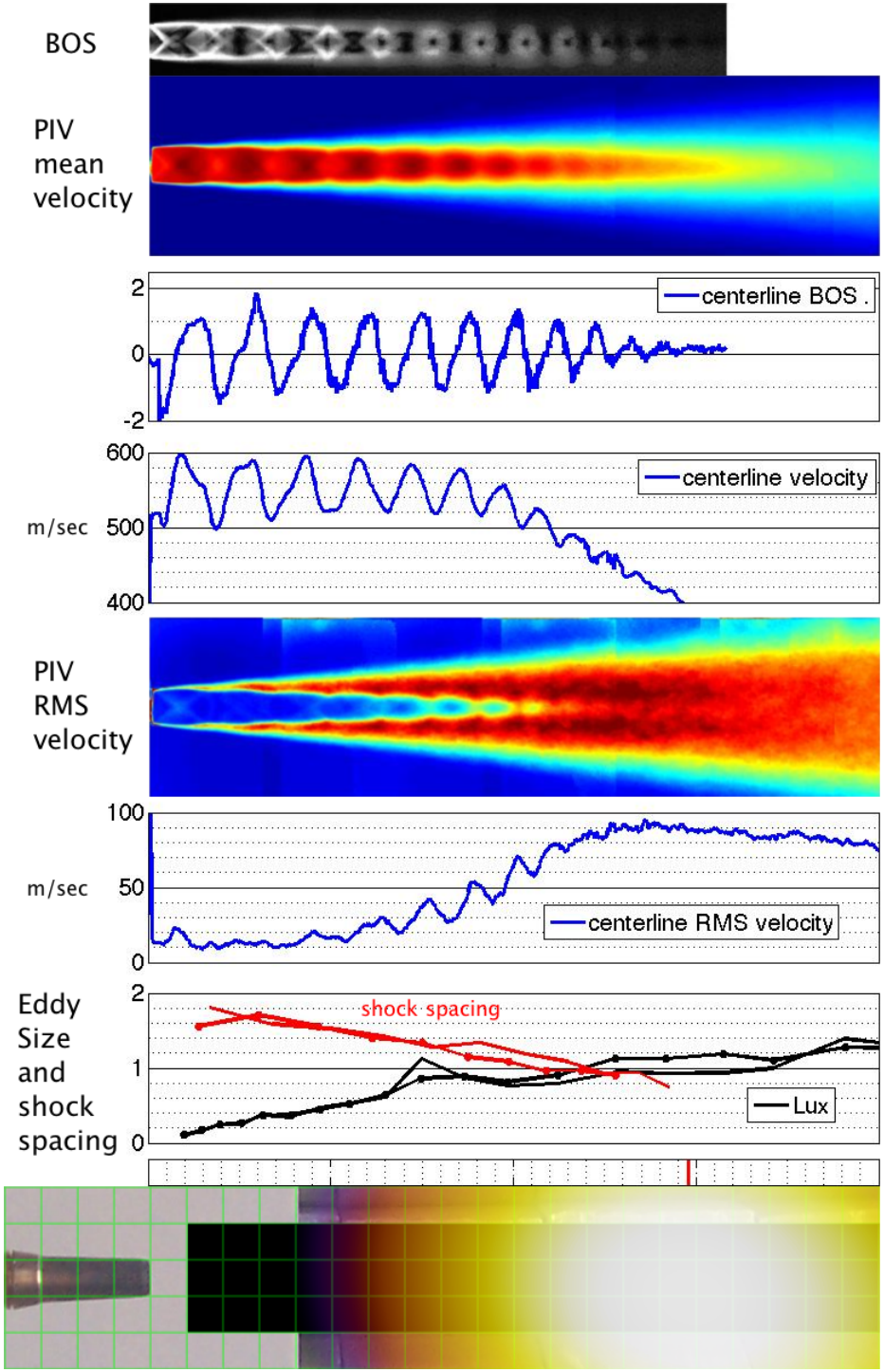
Mjdesign=1.50





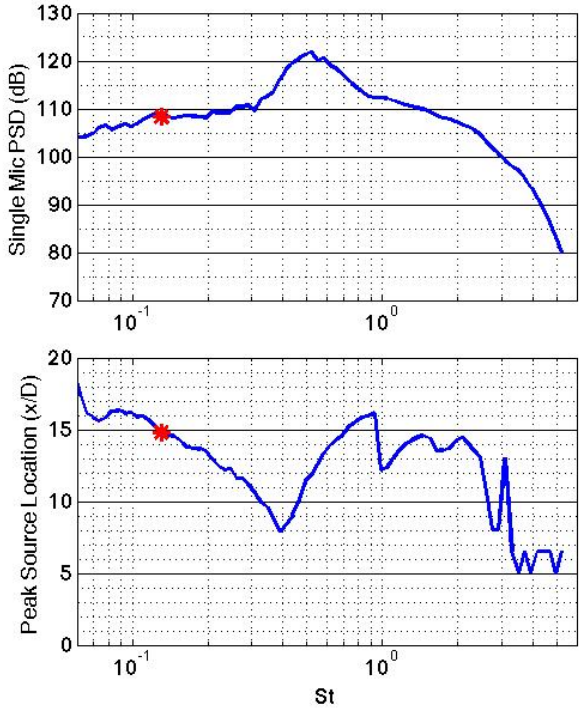
SMC016

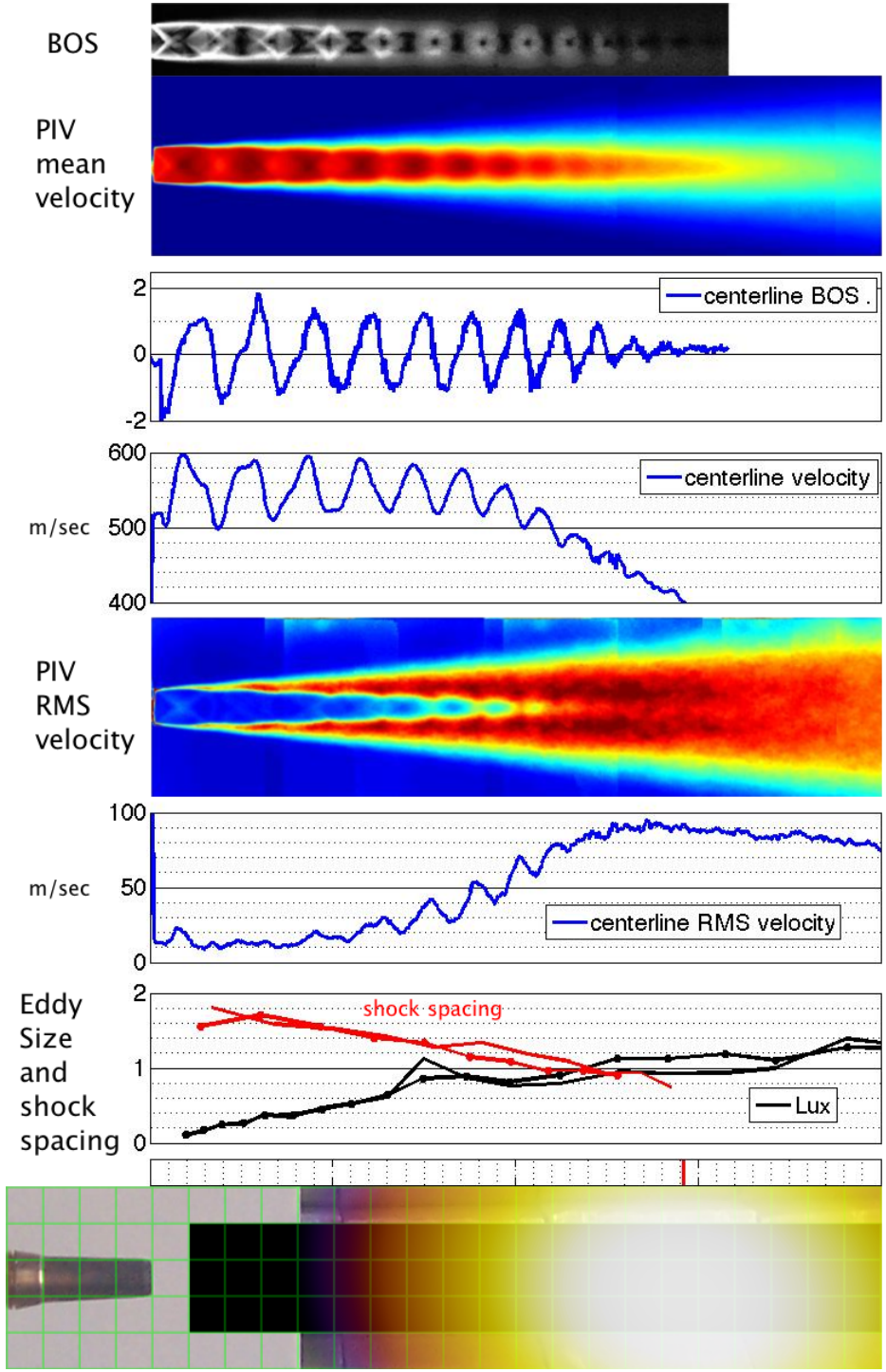
under-expanded

set pt 11617

Mj=1.61

Mjdesign=1.50





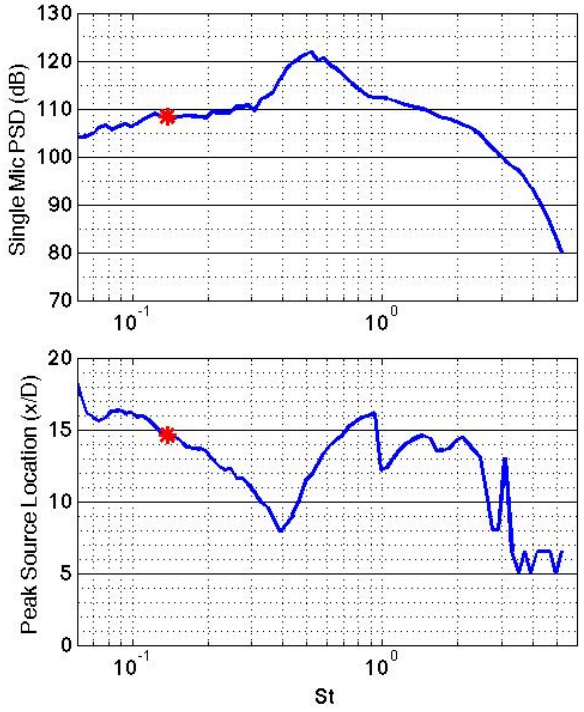
SMC016

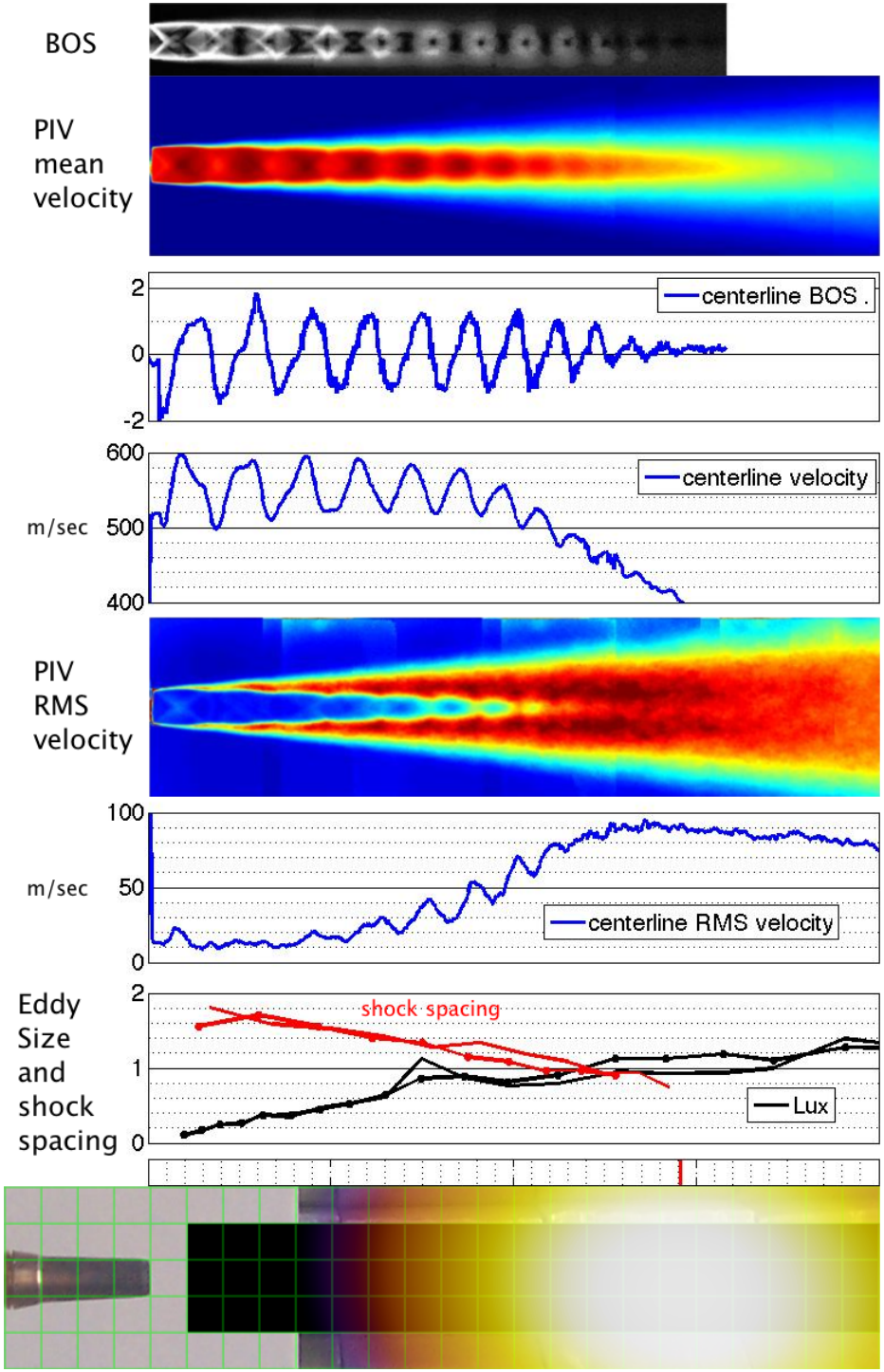
under-expanded

set pt 11617

Mj=1.61

Mjdesign=1.50





SMC016

under-expanded

set pt 11617

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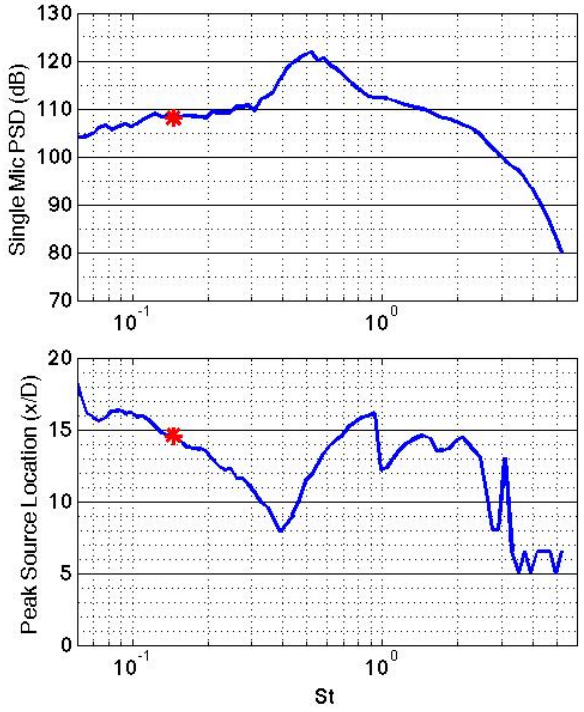
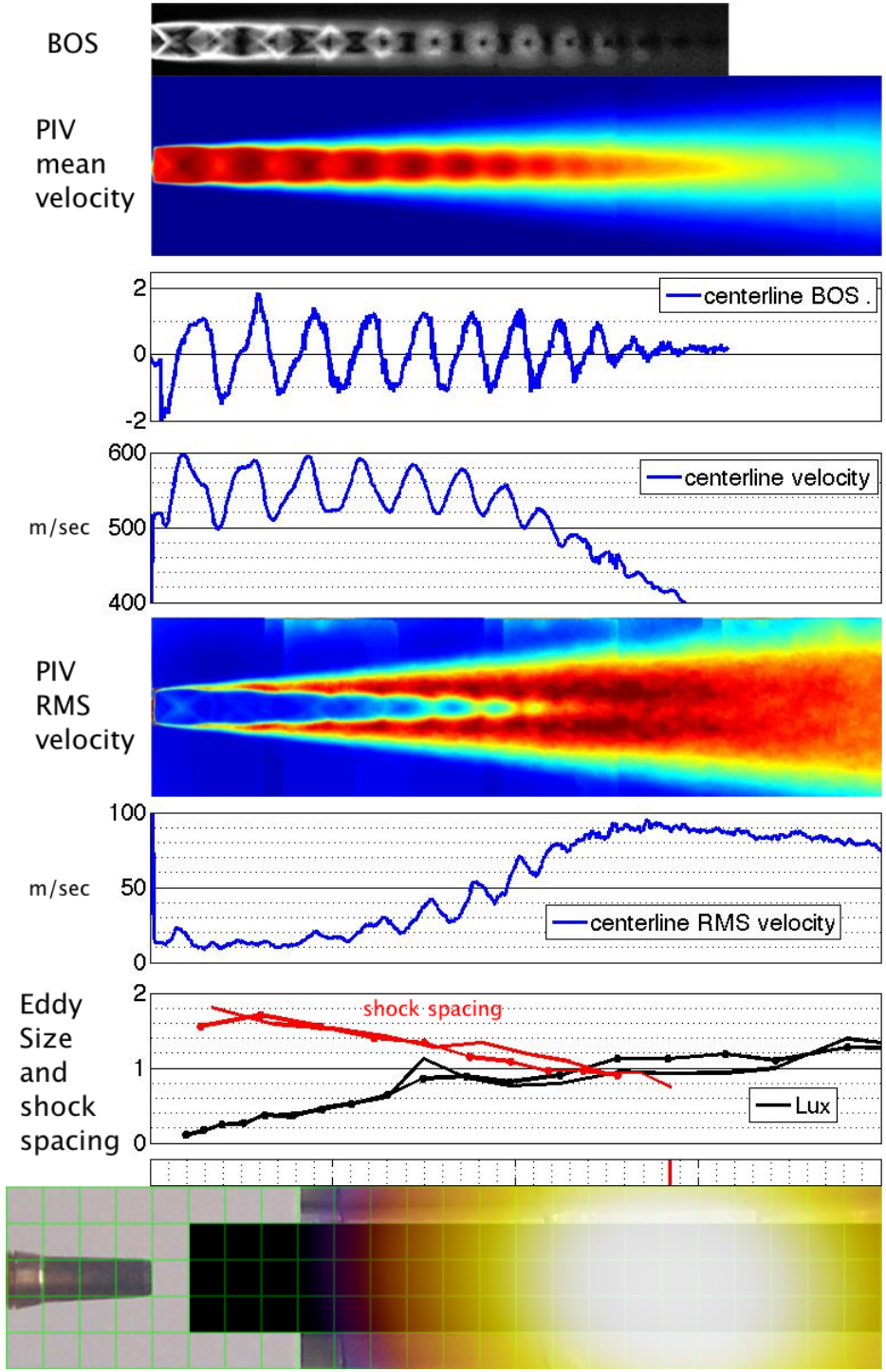
Mjdesign=1.50





SMC016

under-expanded

set pt 11617

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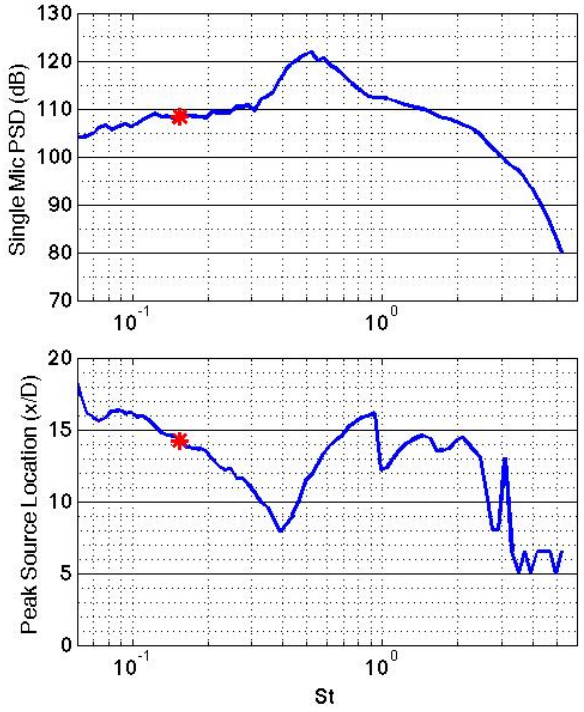
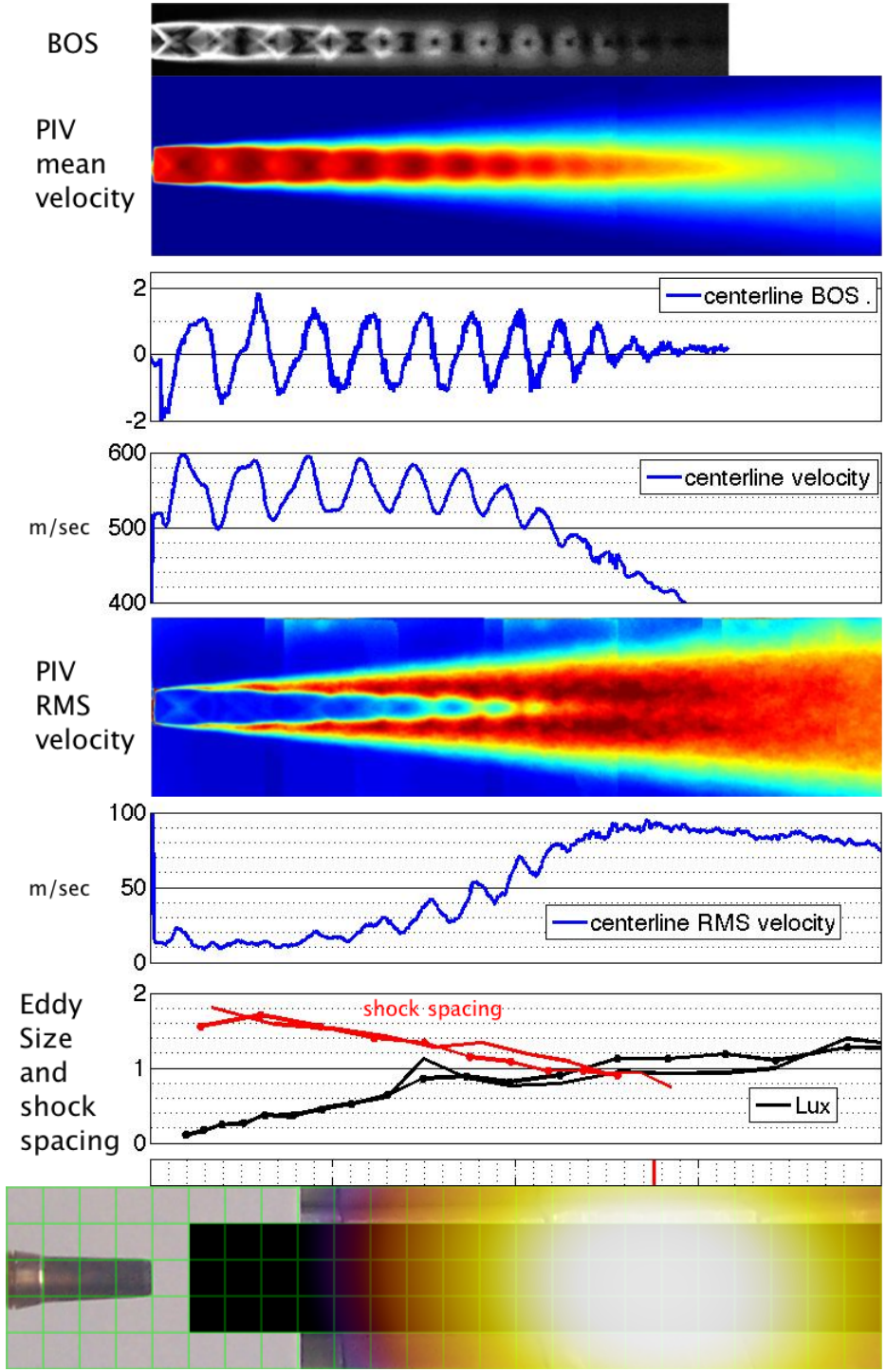
Mjdesign=1.50





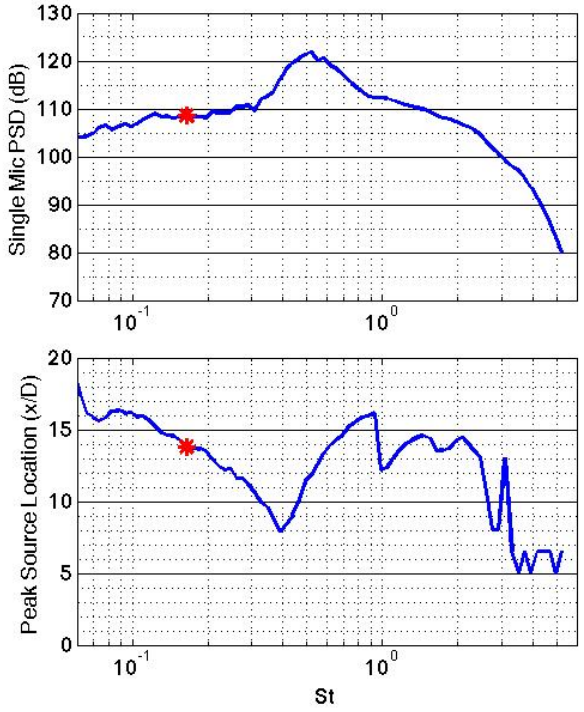
SMC016

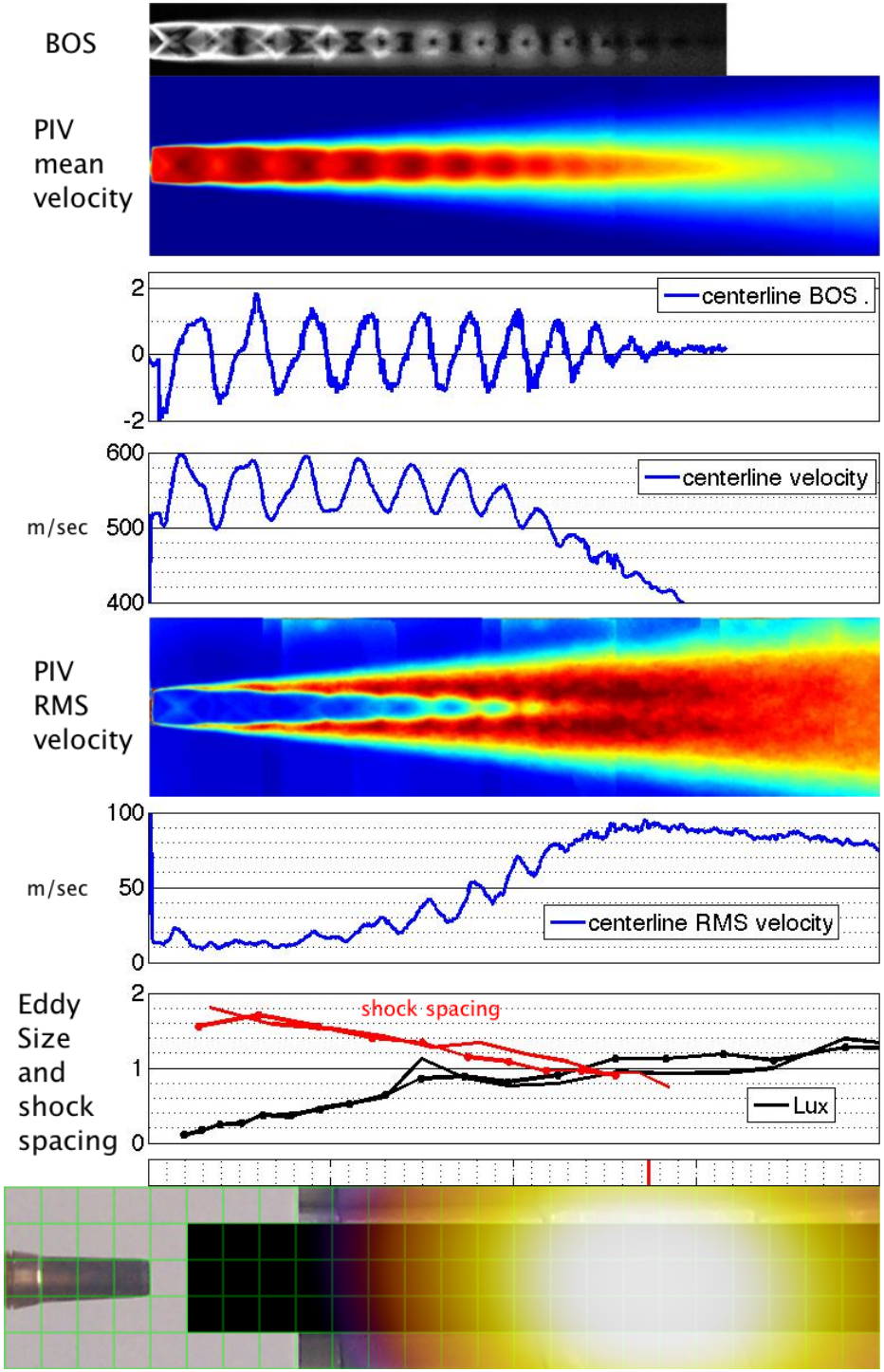
under-expanded

set pt 11617

Mj=1.61

Mjdesign=1.50





SMC016

under-expanded

set pt 11617

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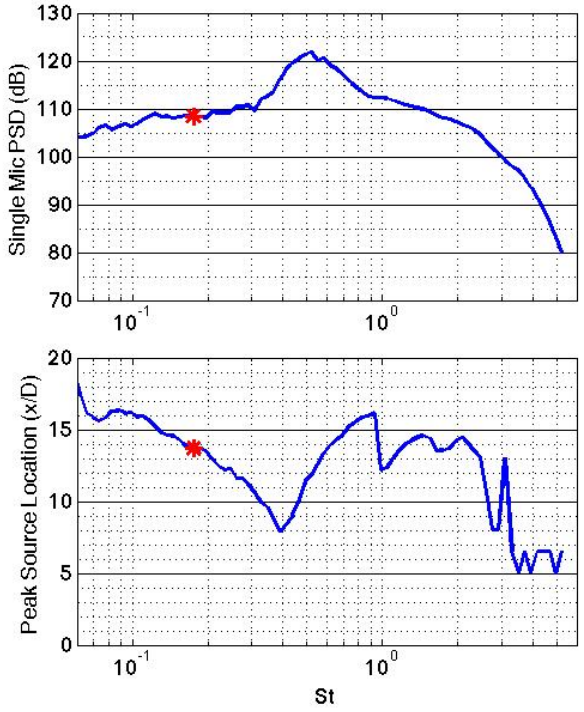
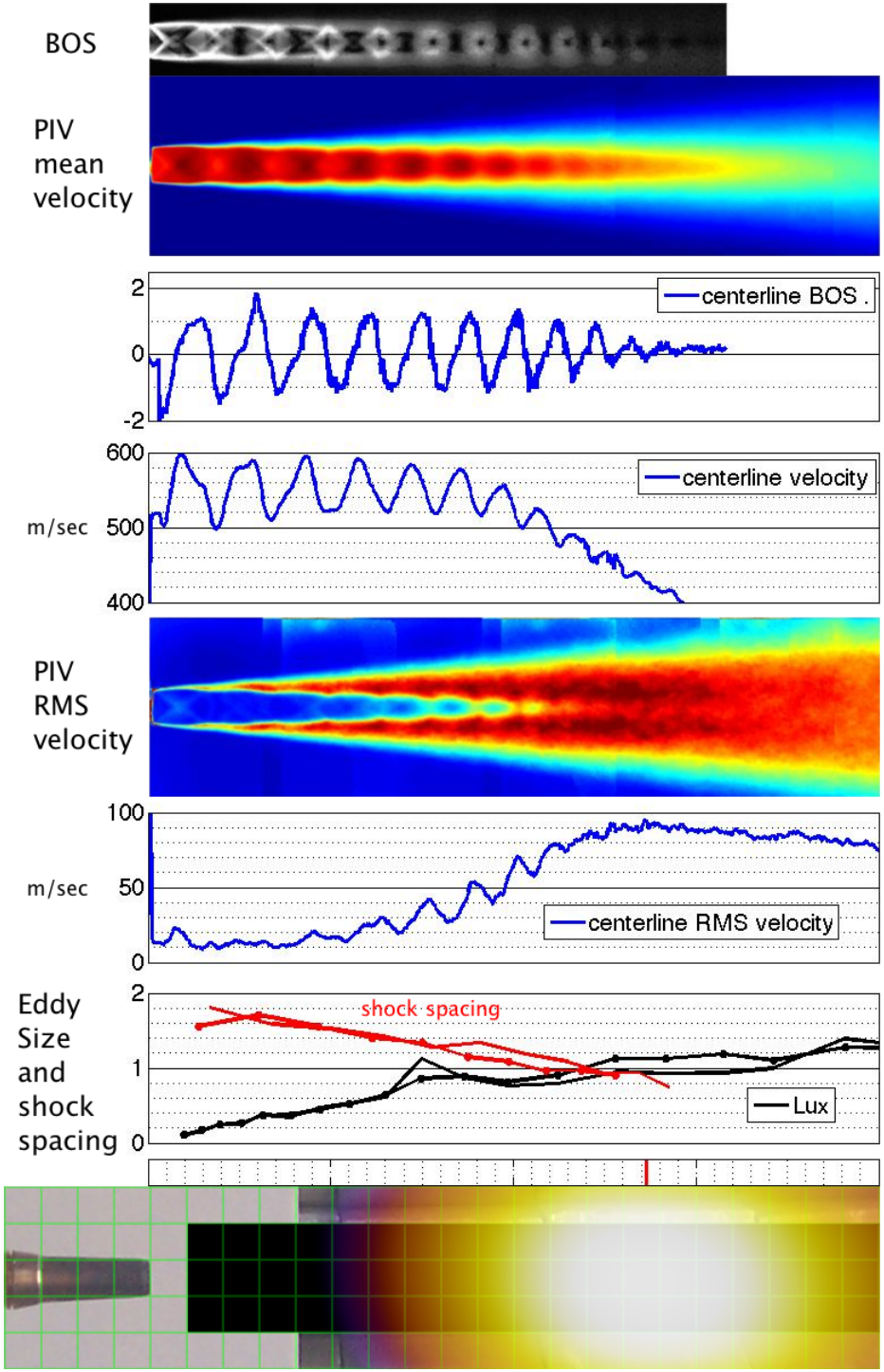
Mjdesign=1.50





SMC016

under-expanded

set pt 11617

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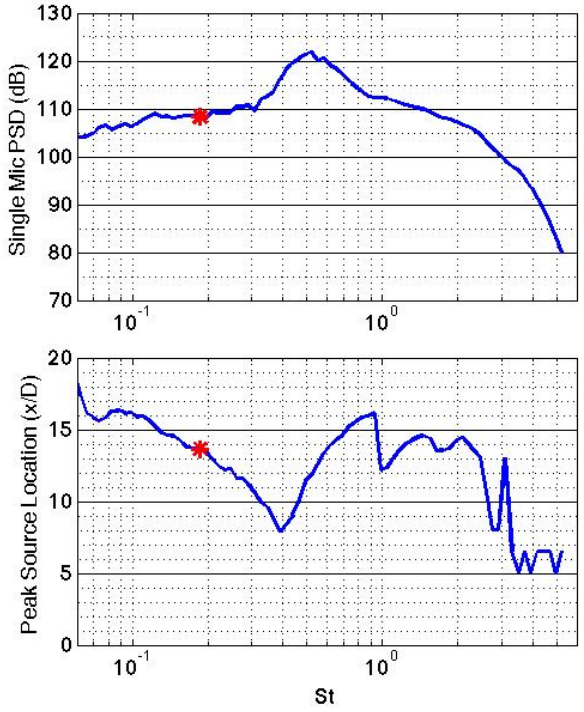

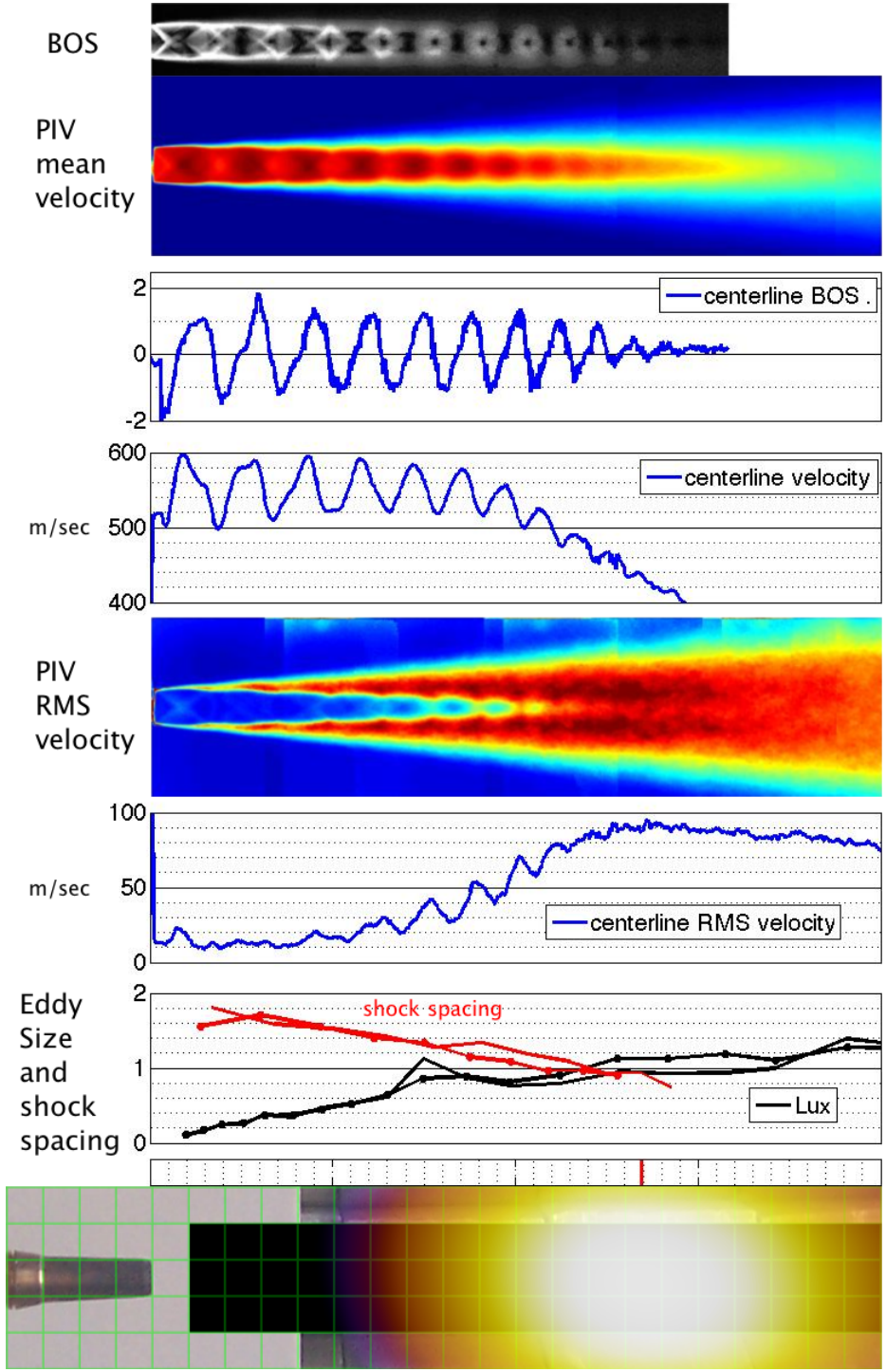

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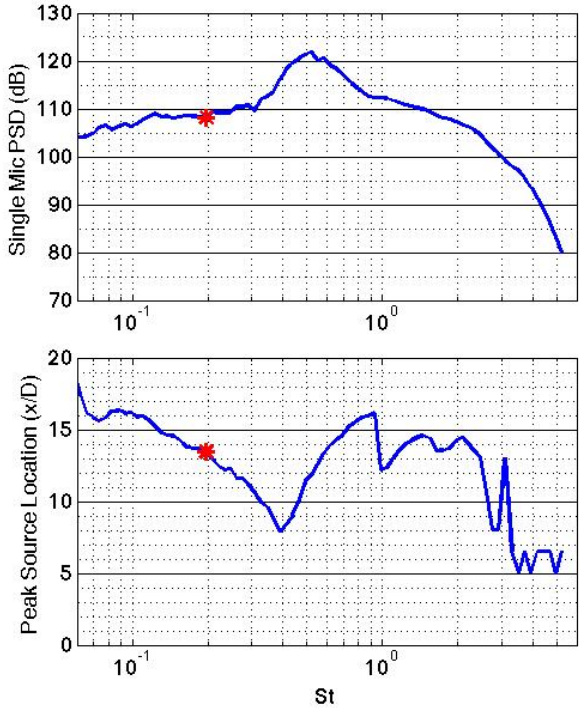

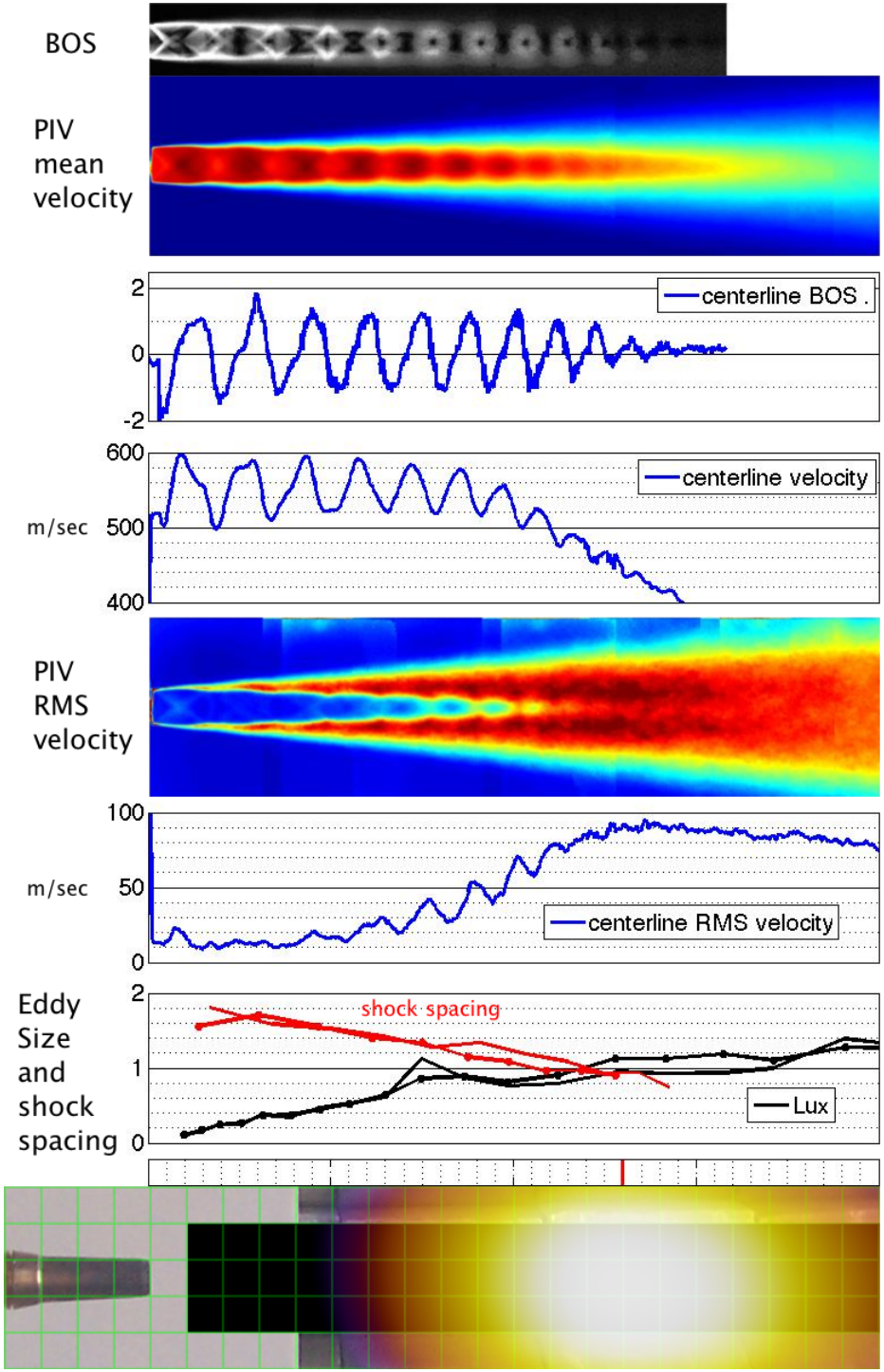

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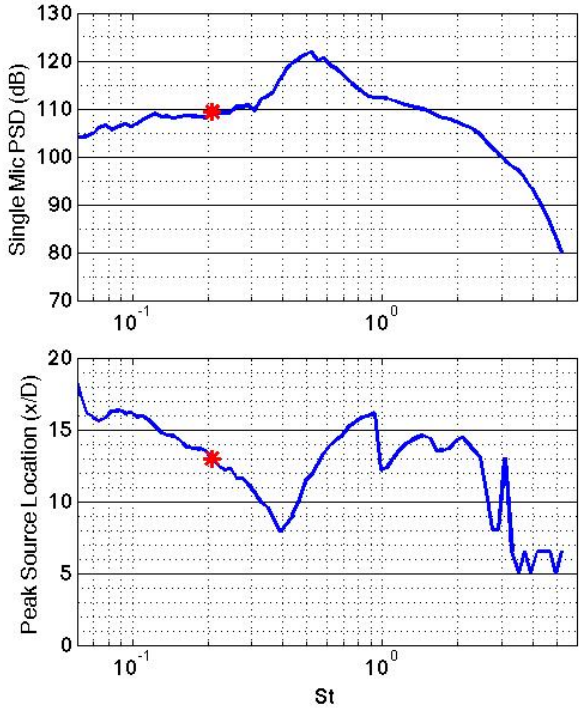

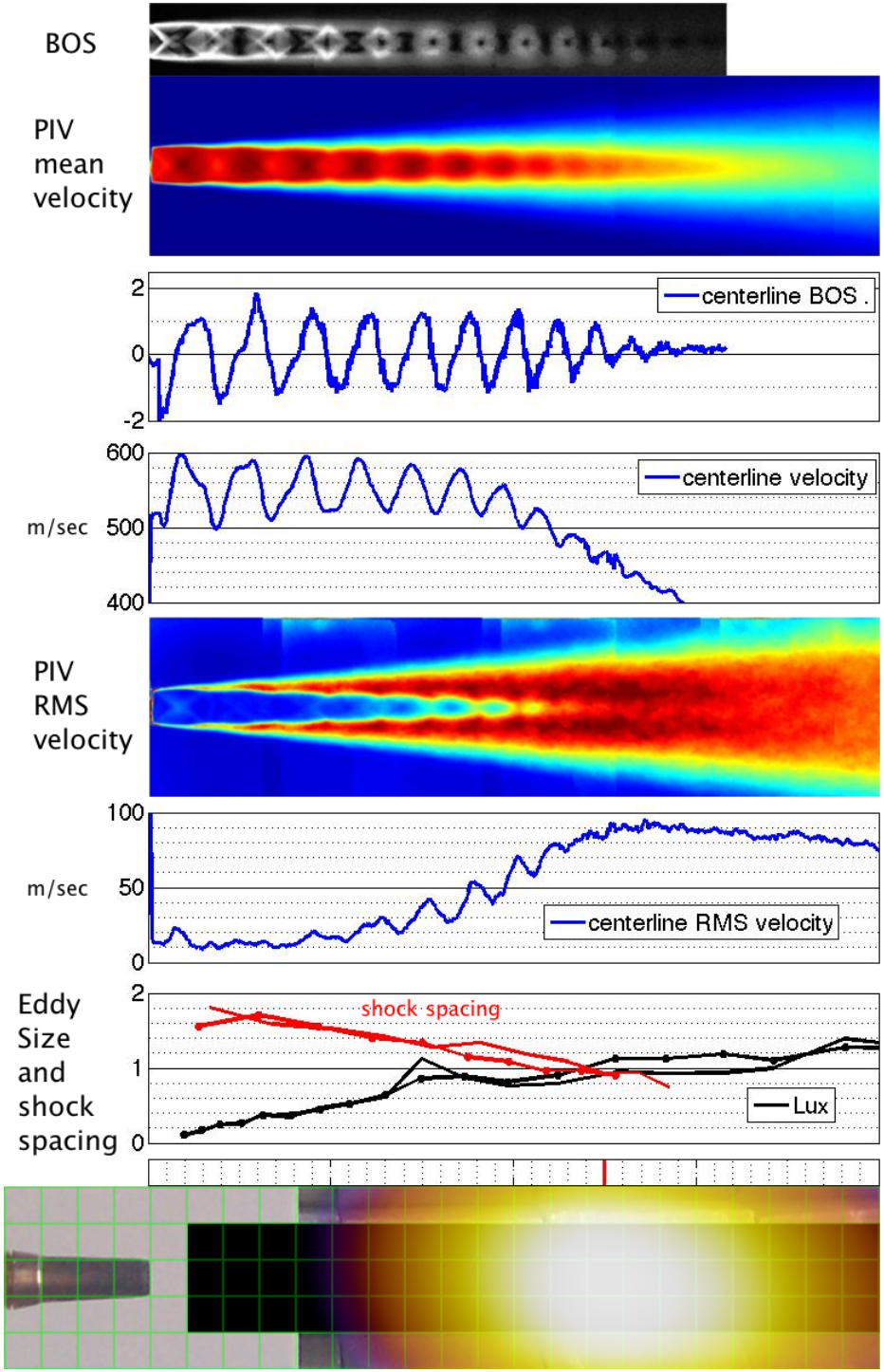

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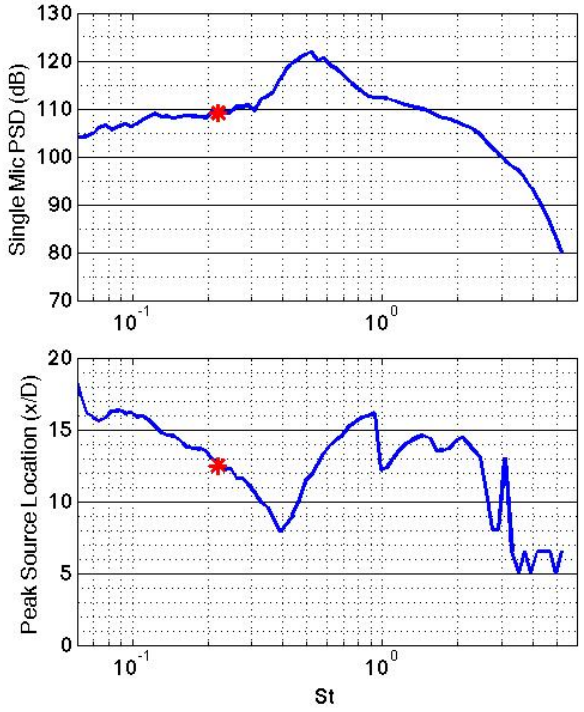

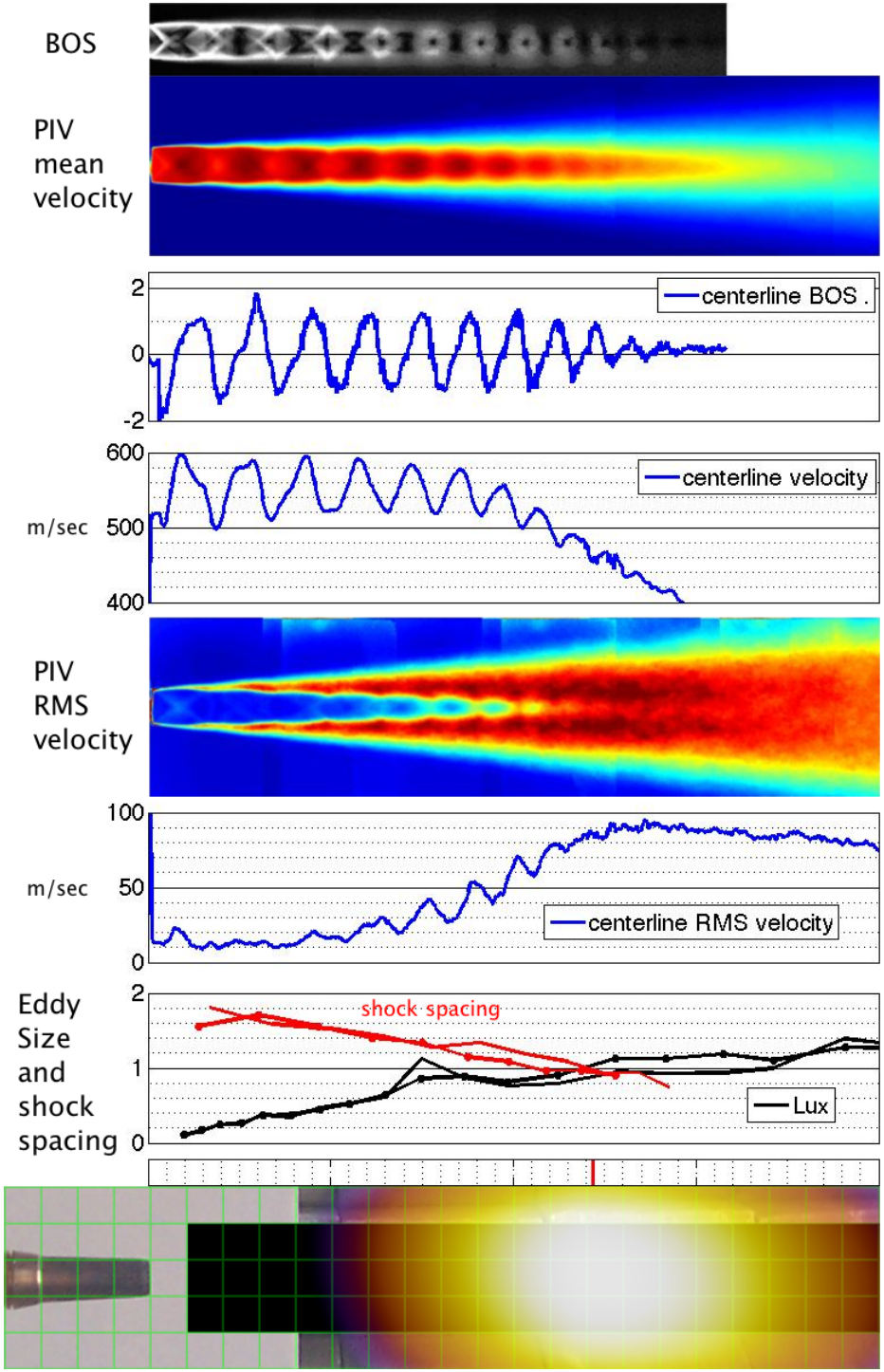

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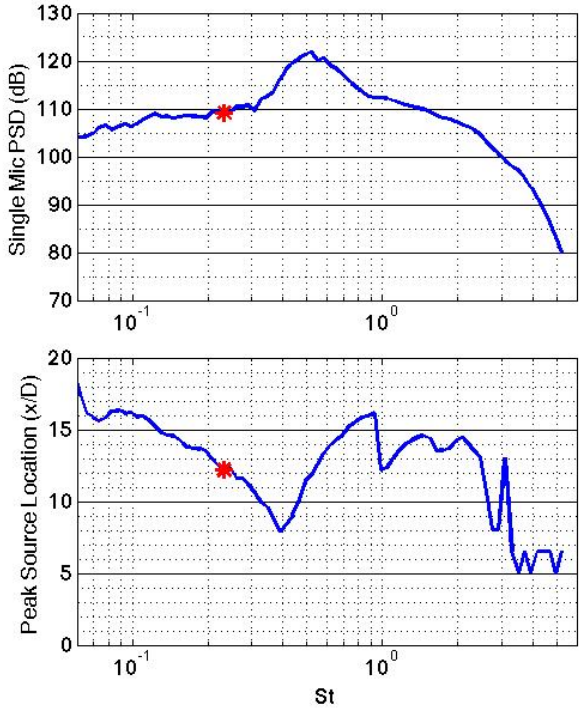

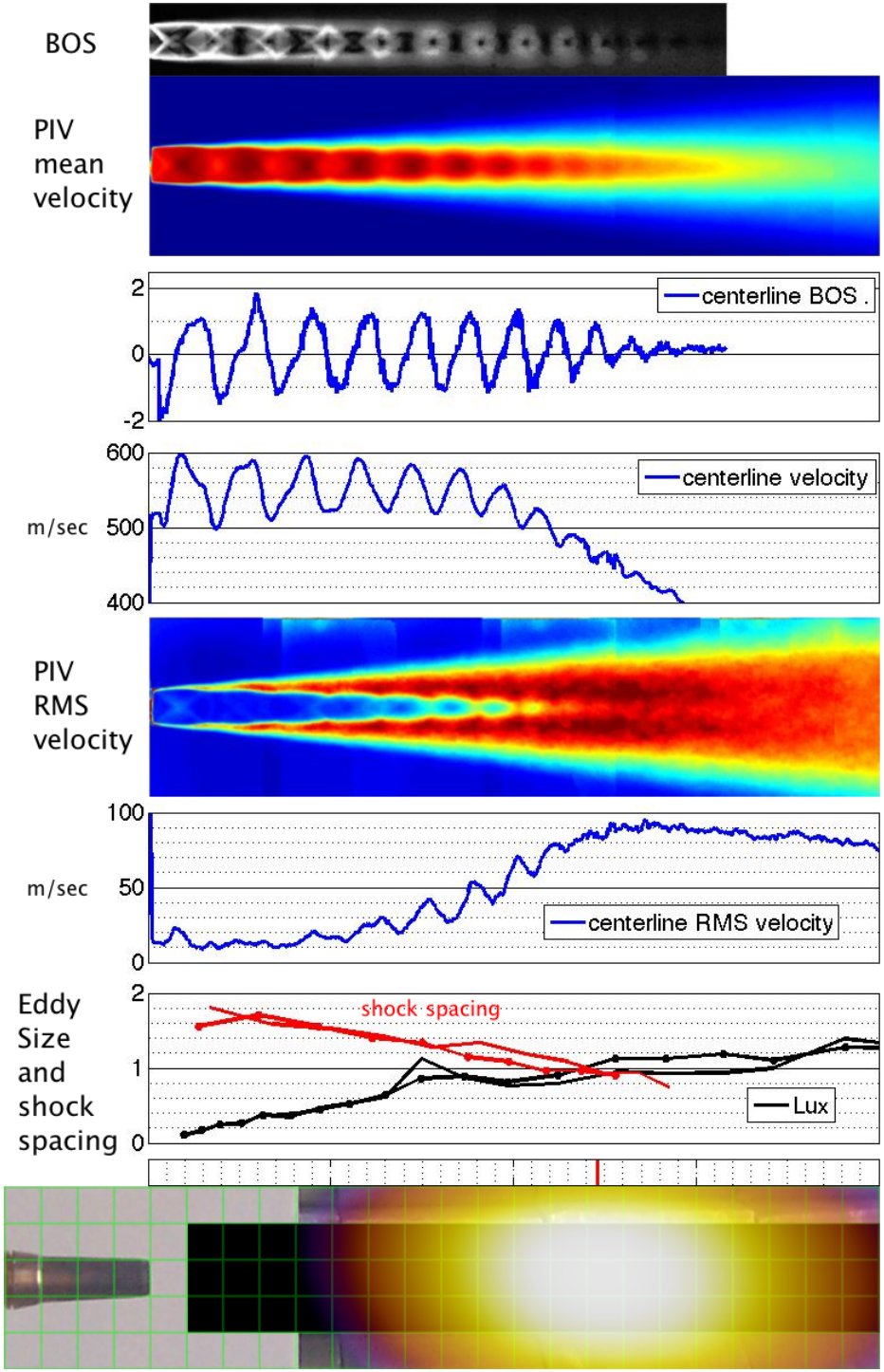

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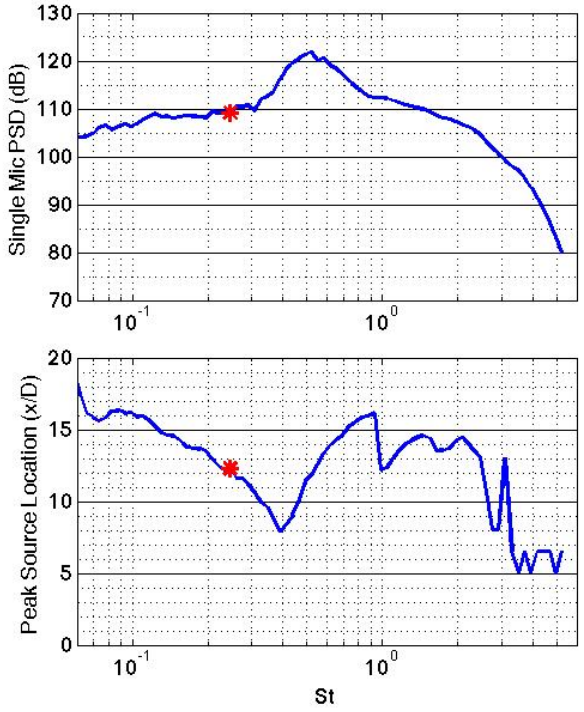

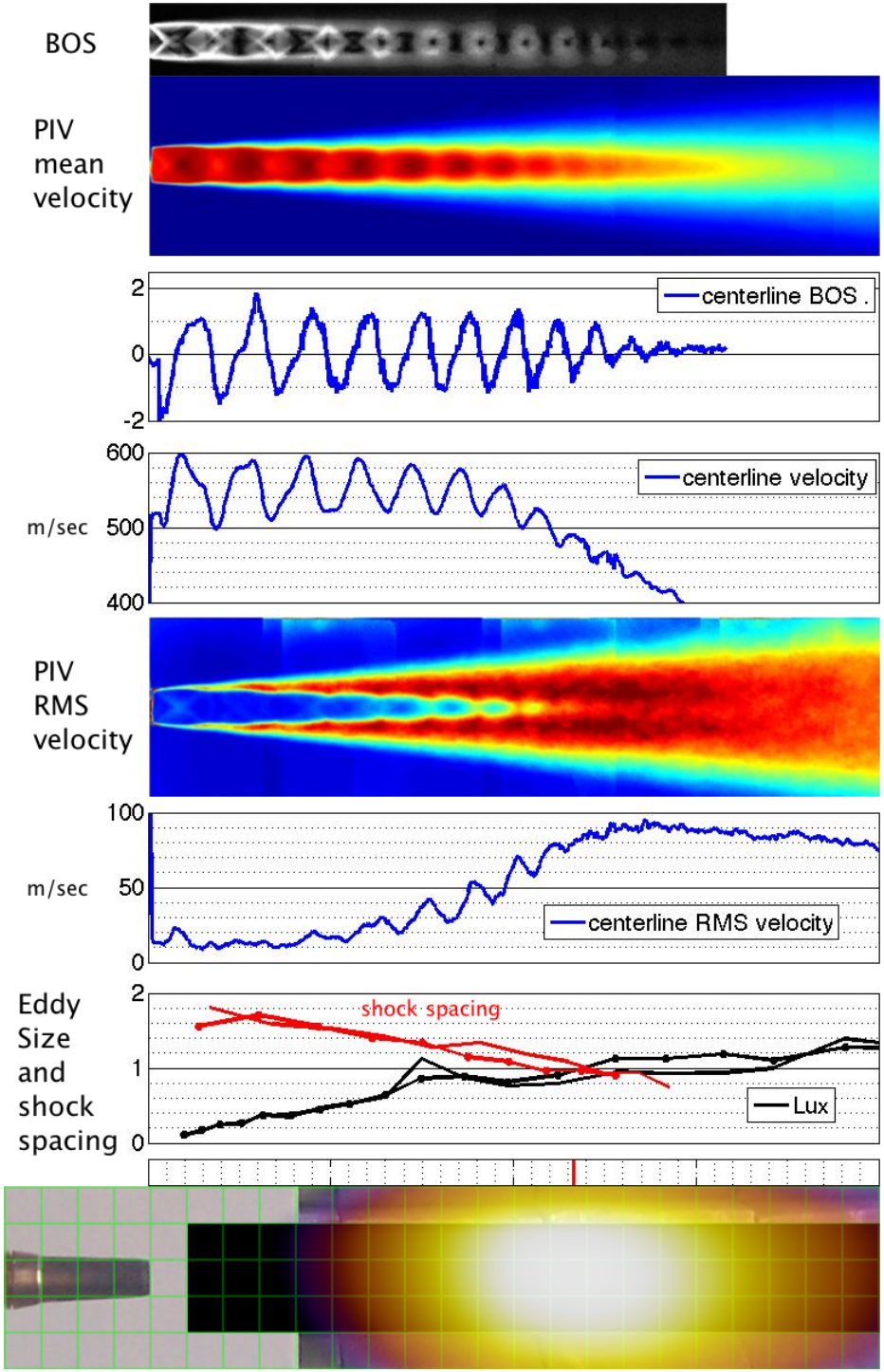

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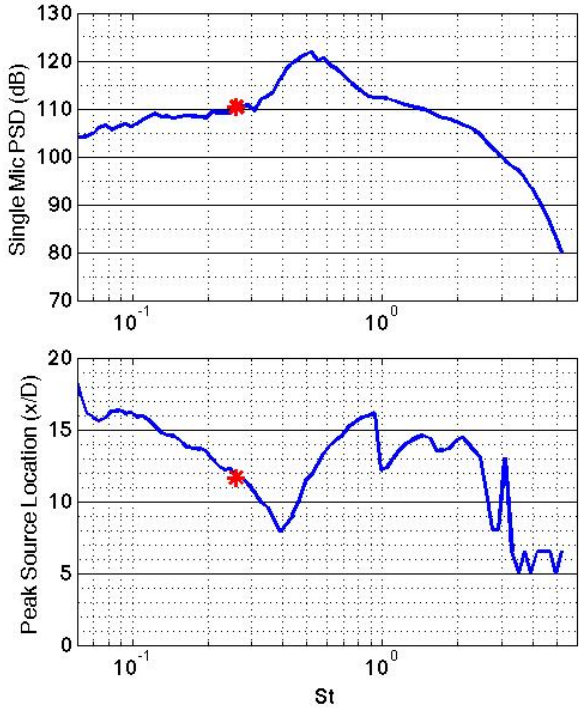

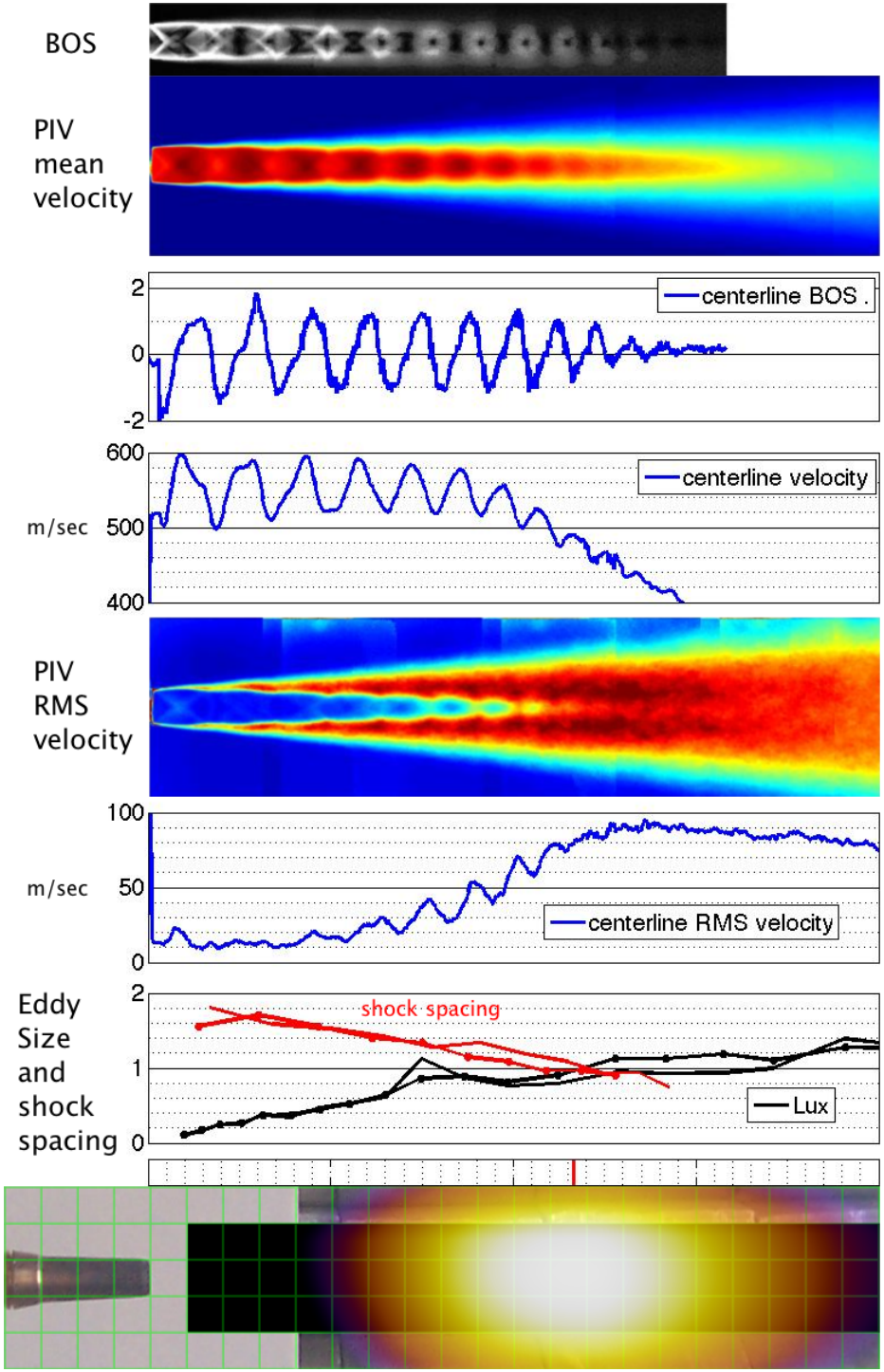

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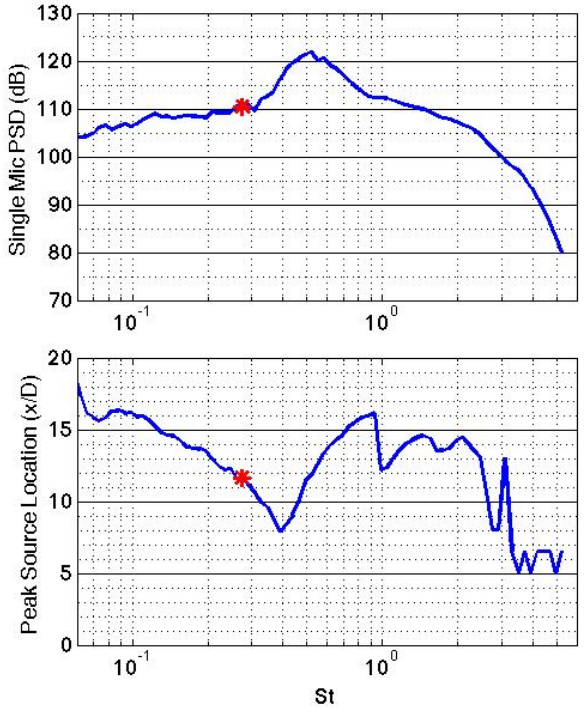

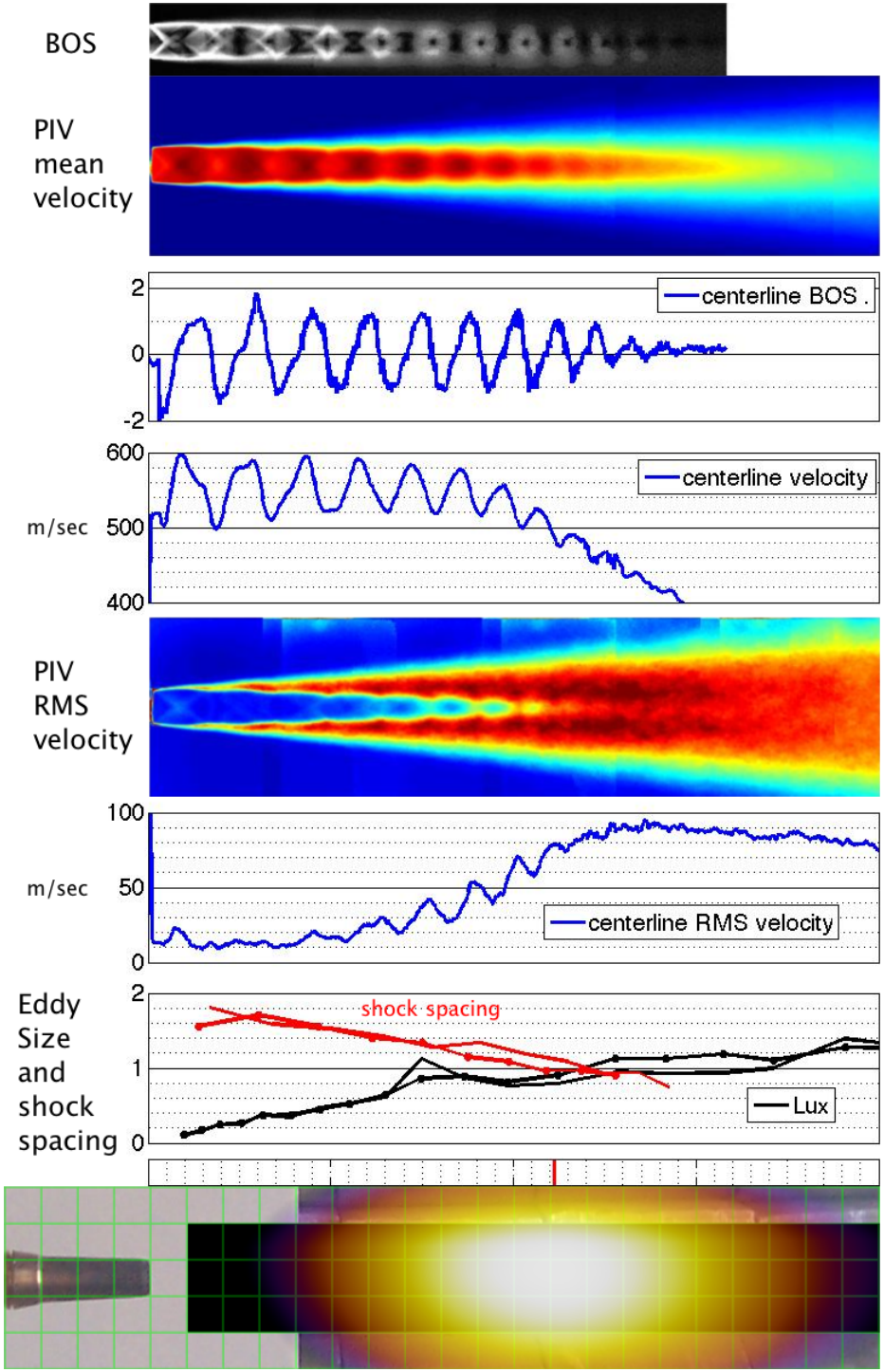

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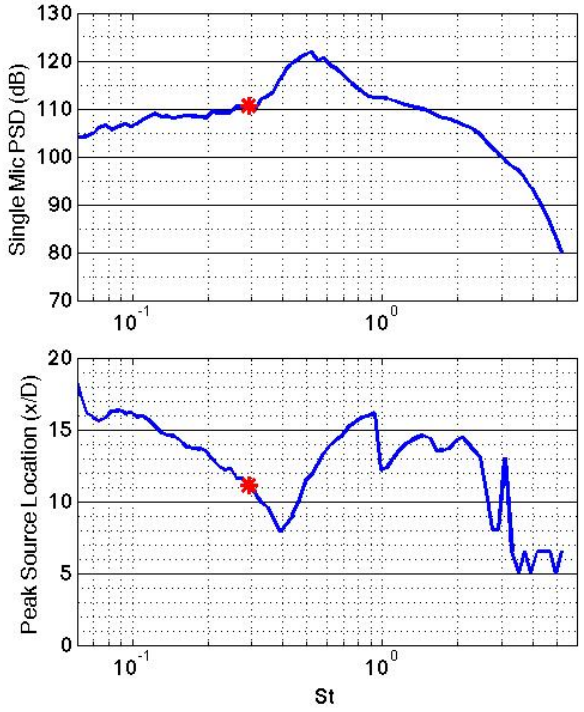

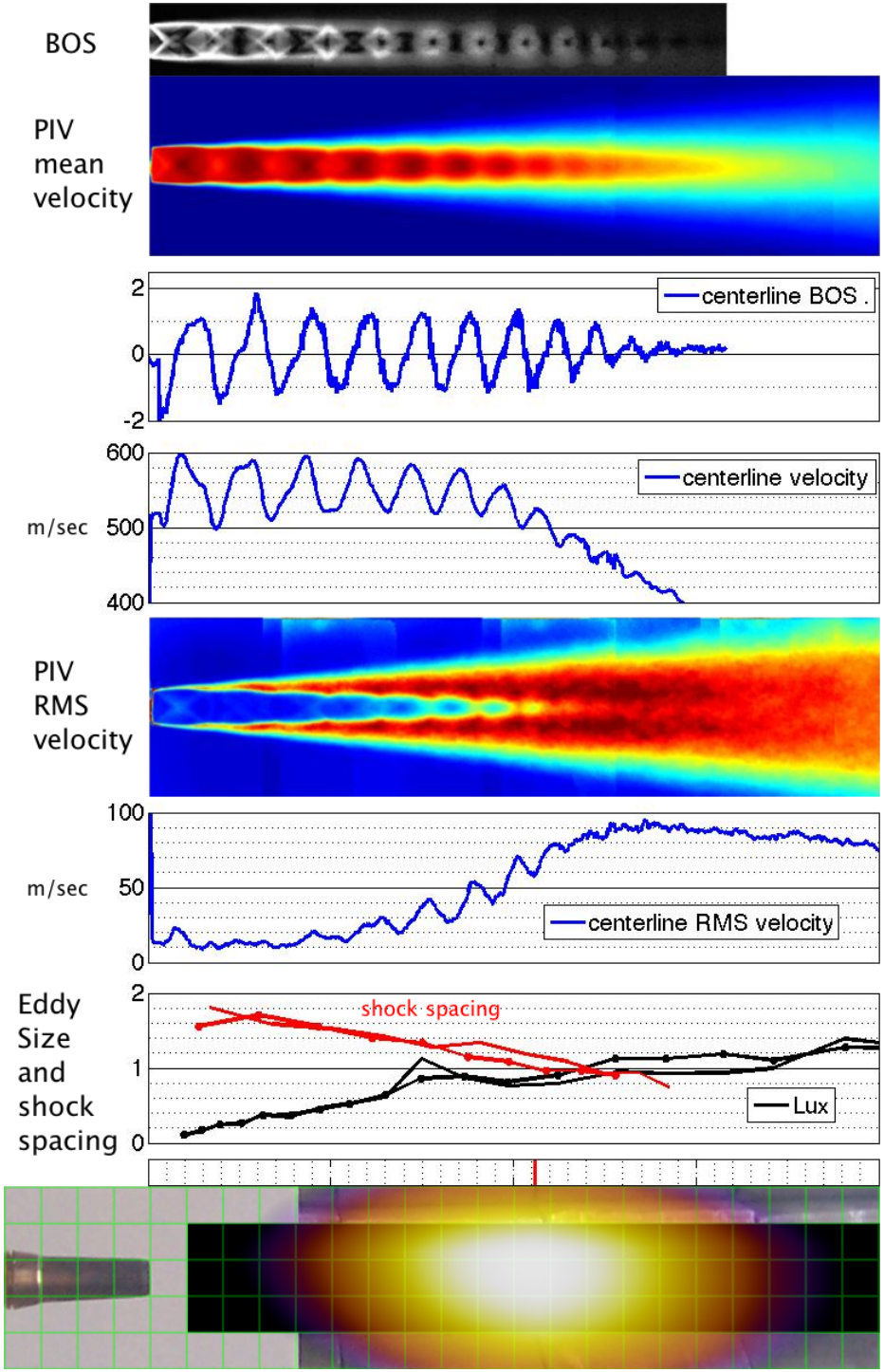

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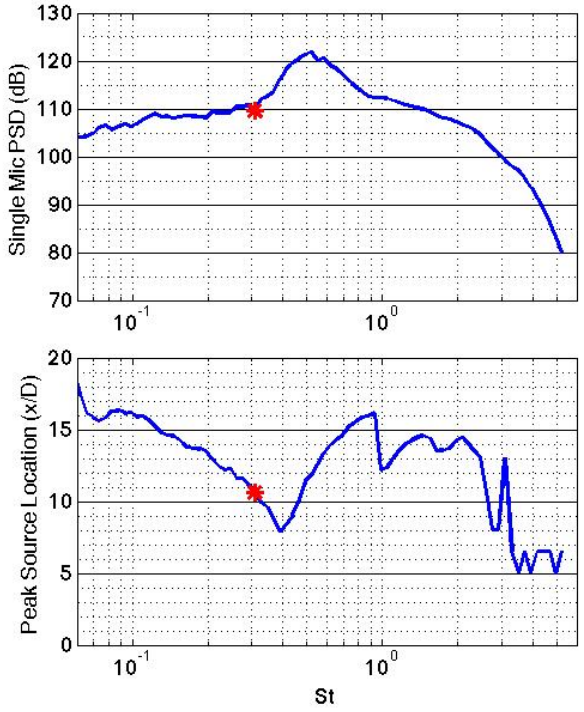

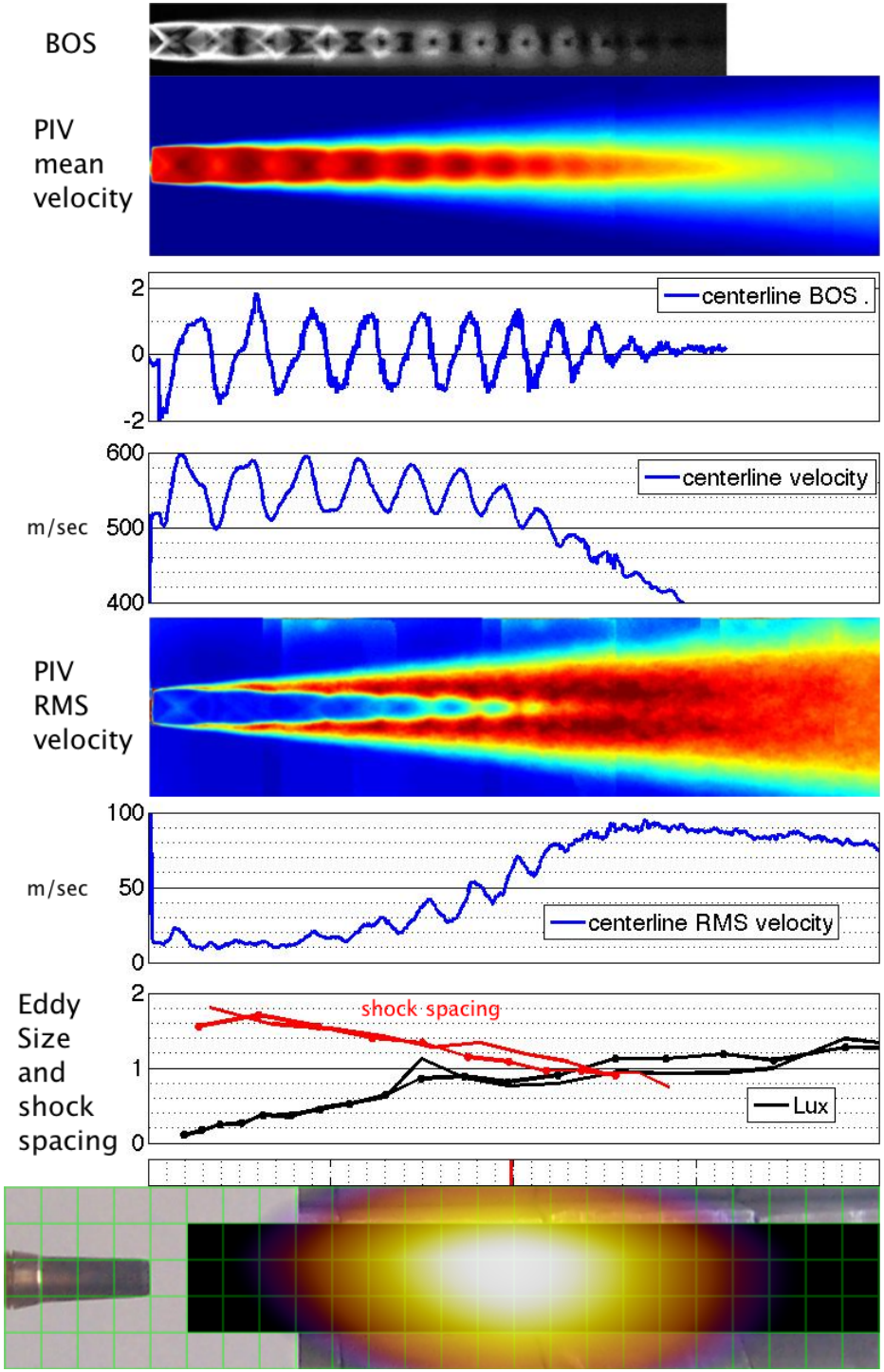

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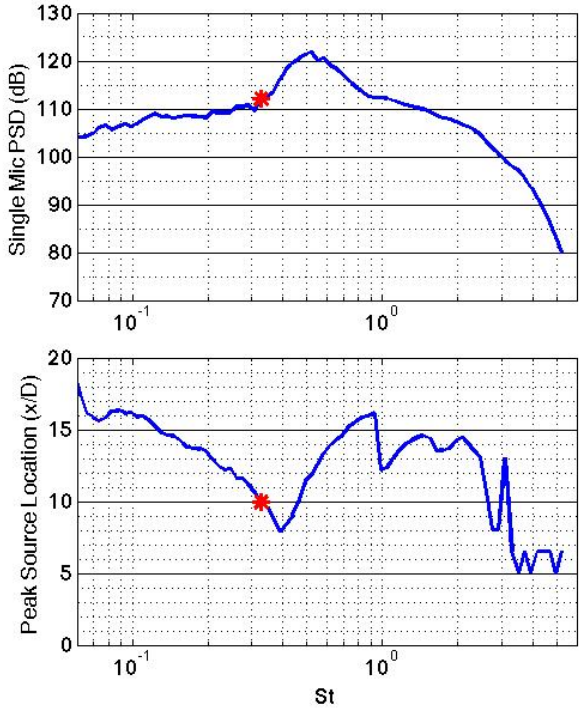

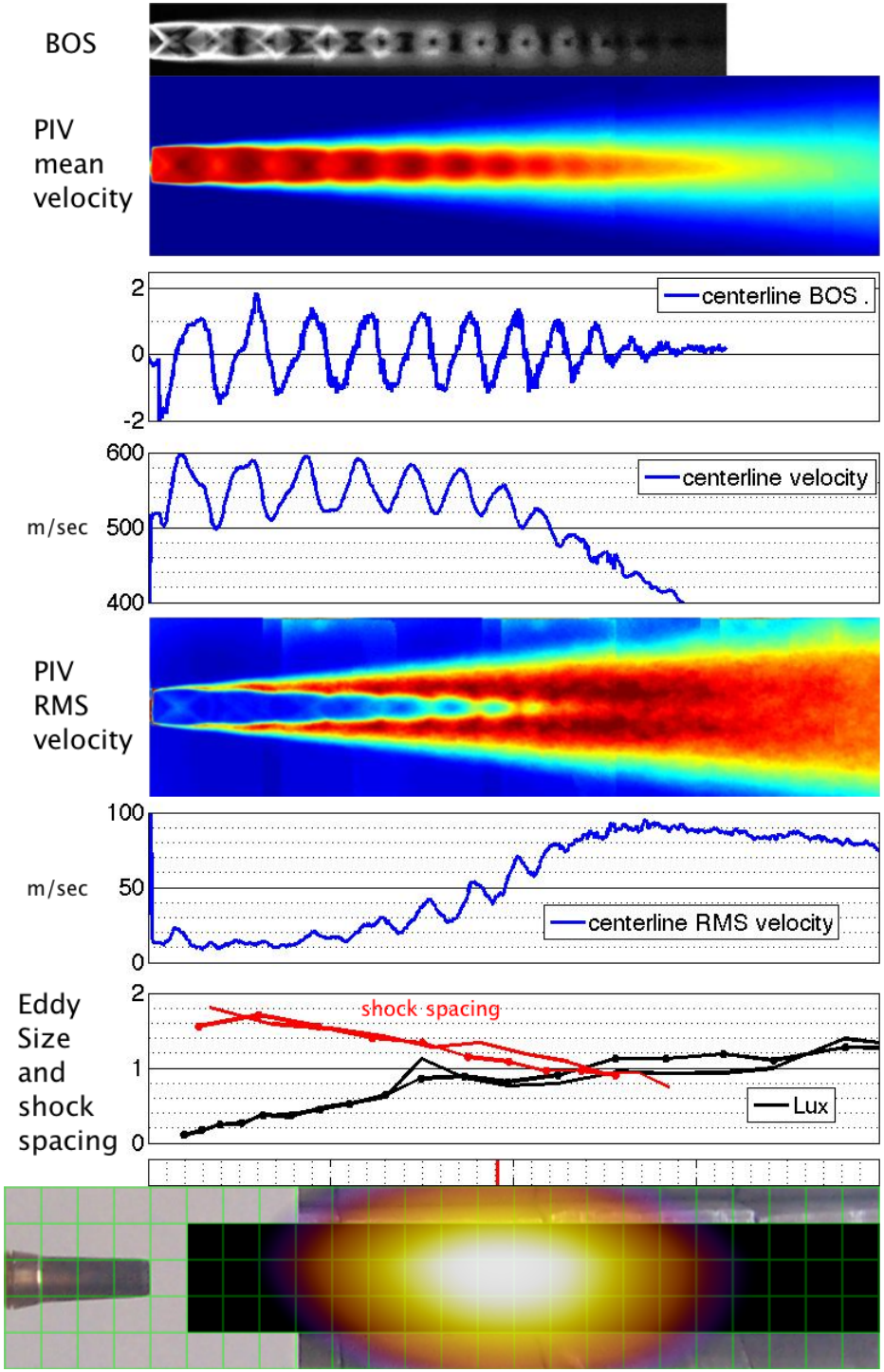

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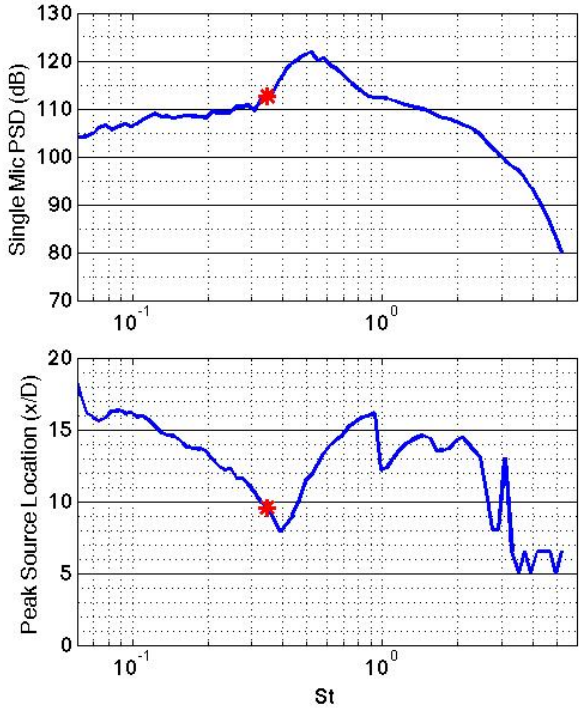

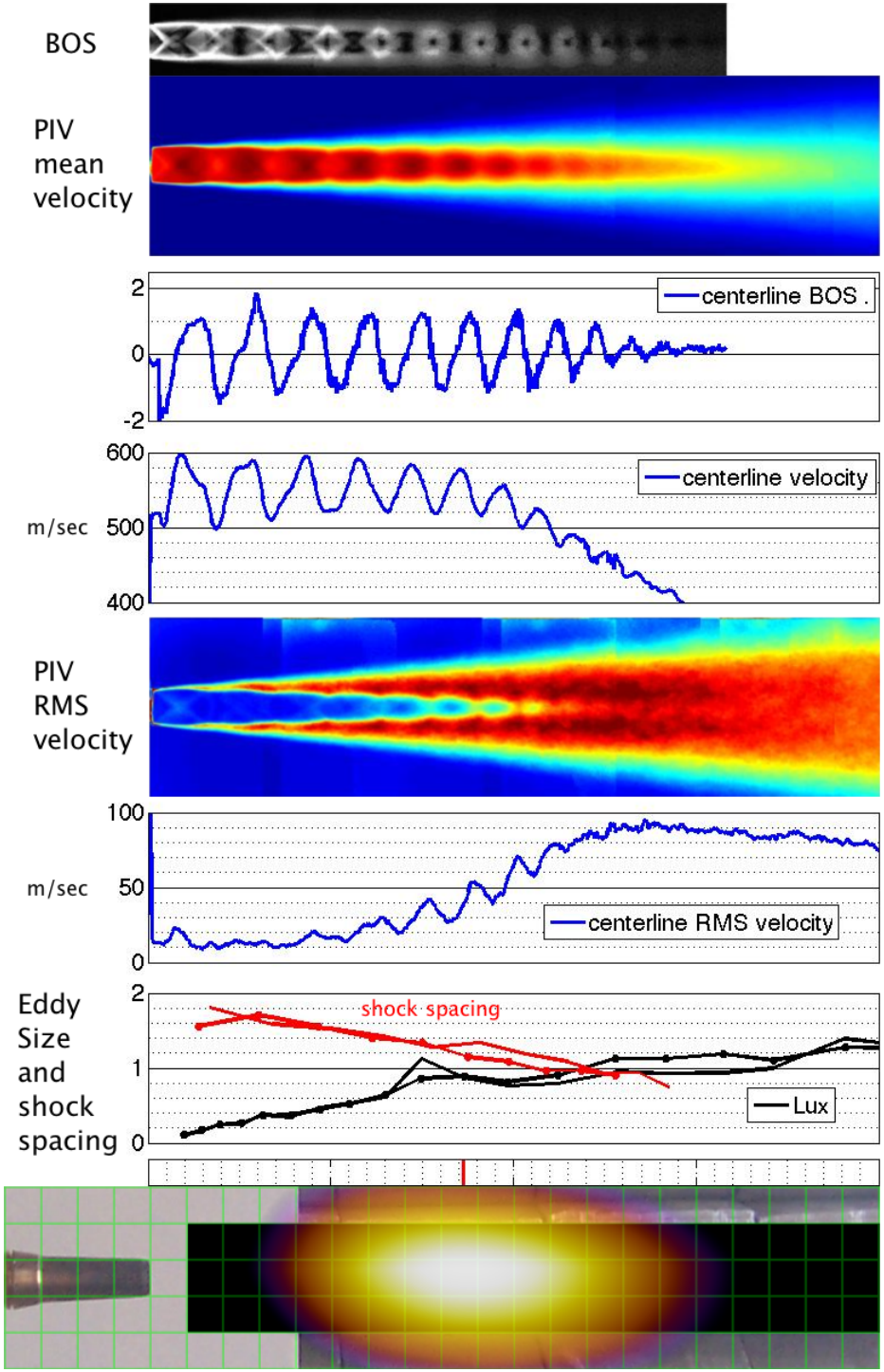

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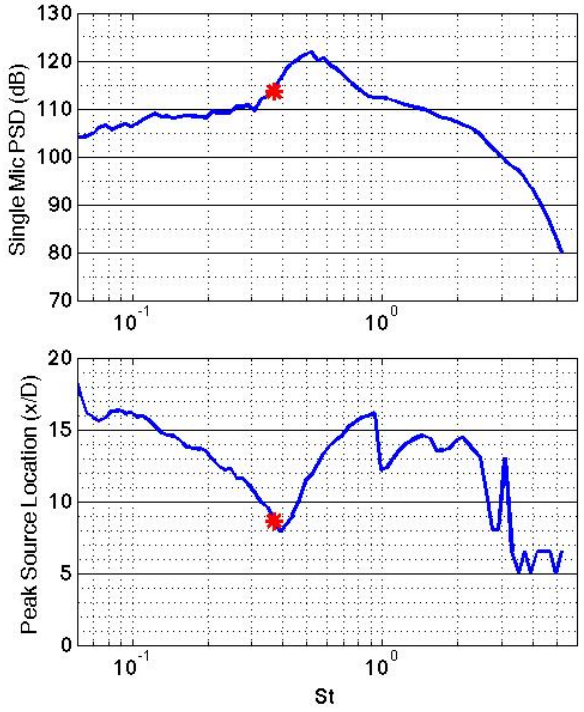

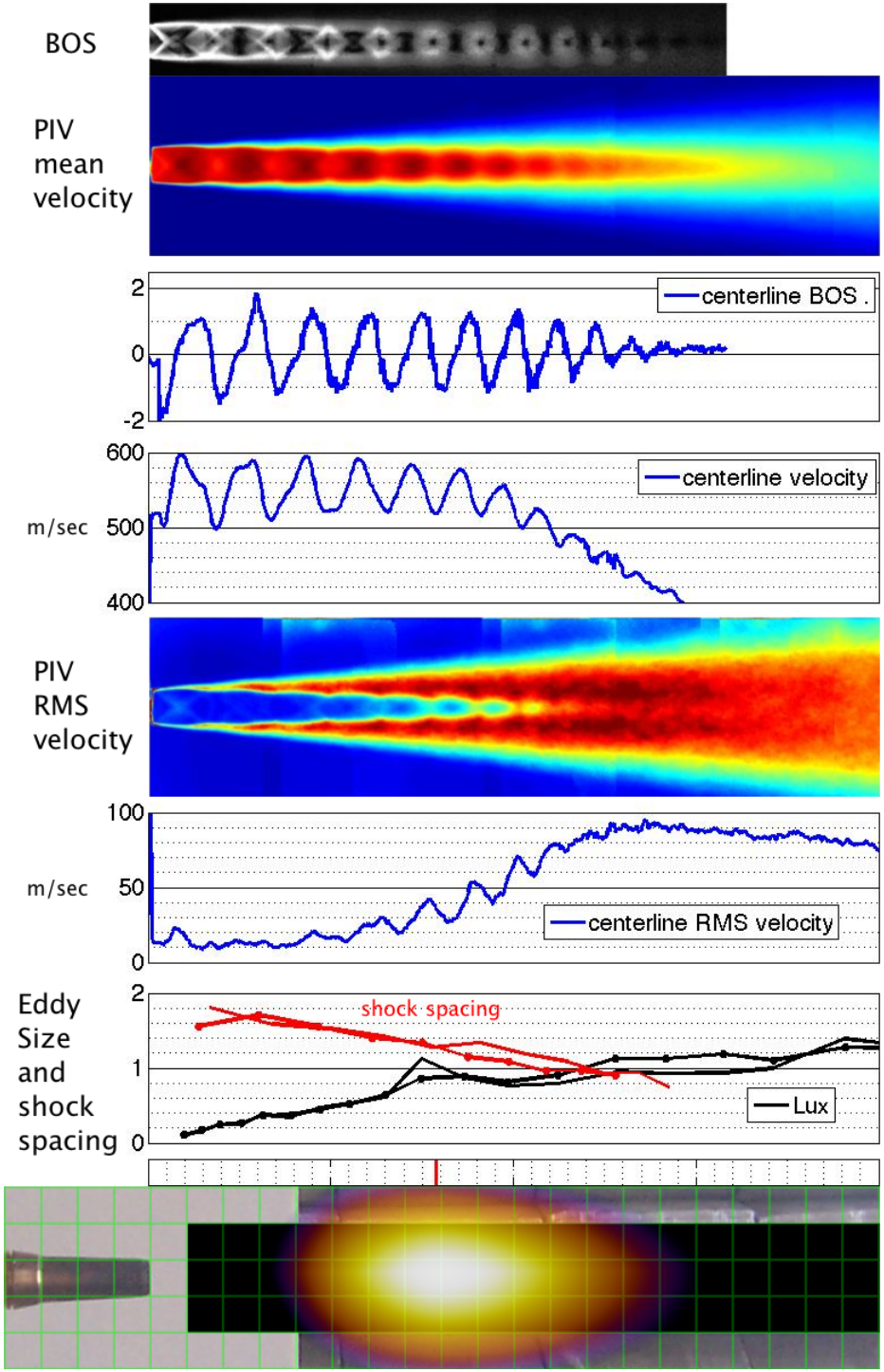

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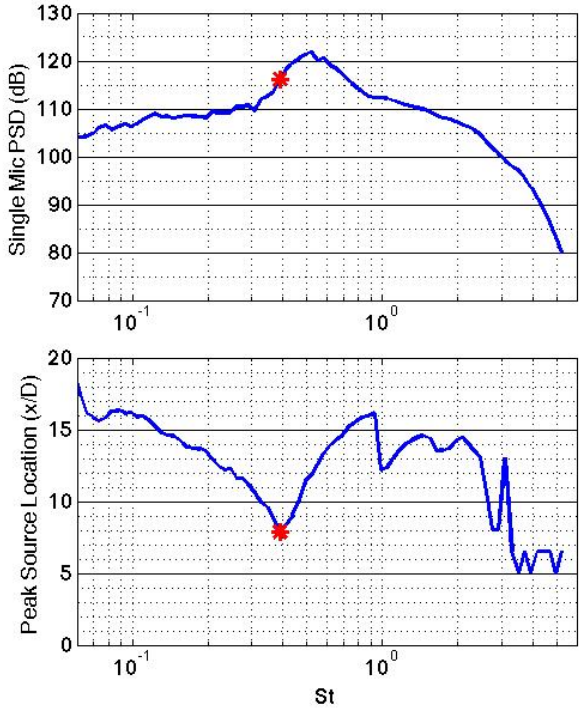

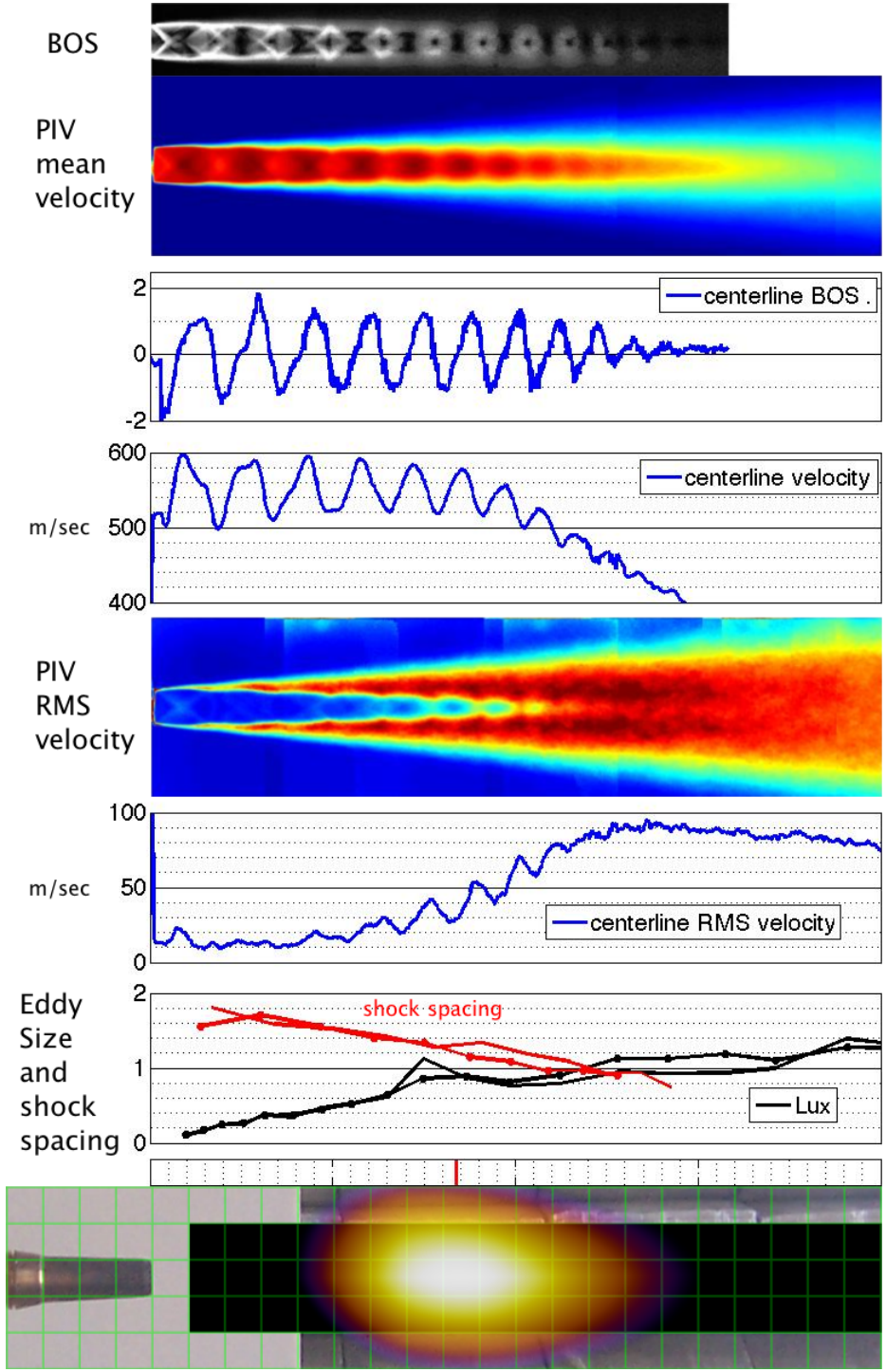

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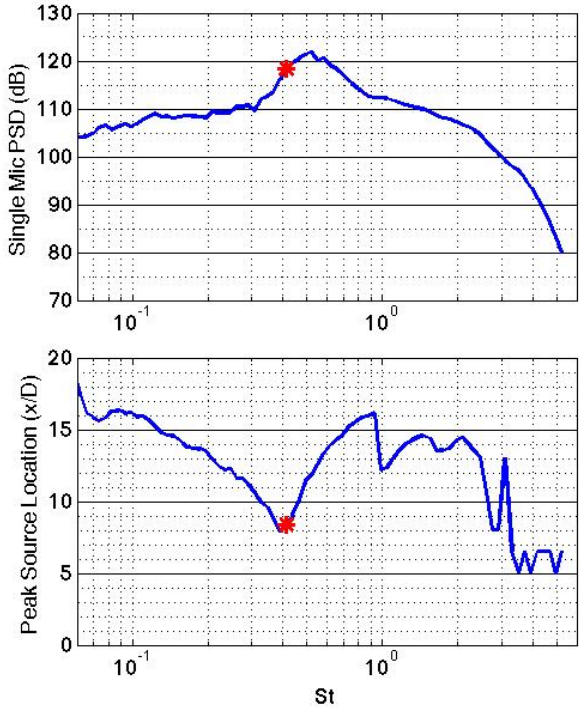

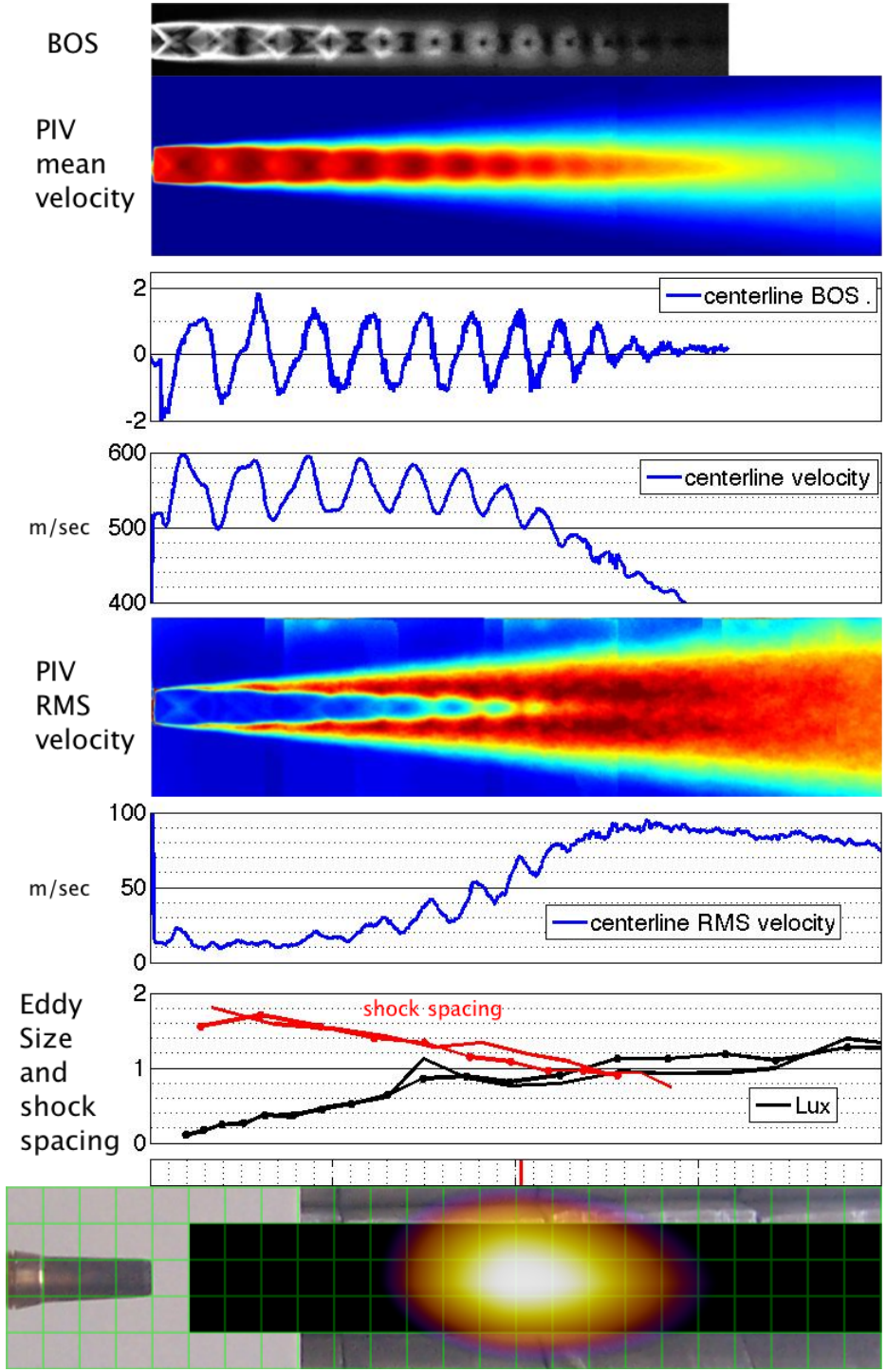

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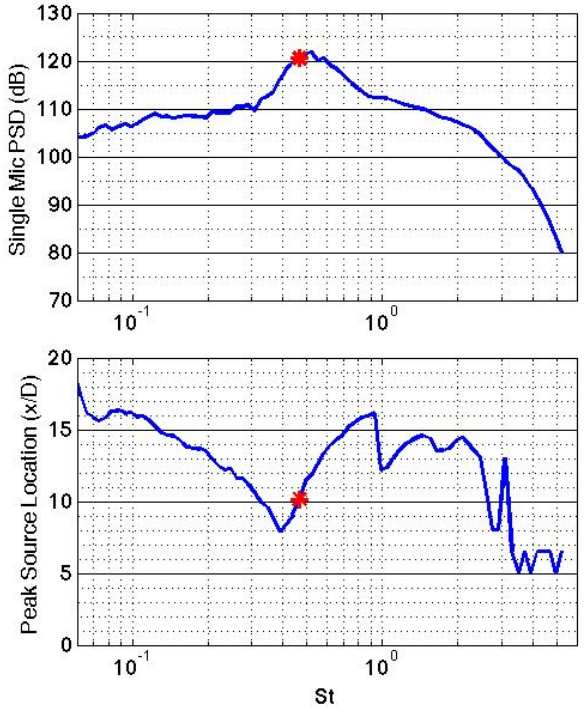

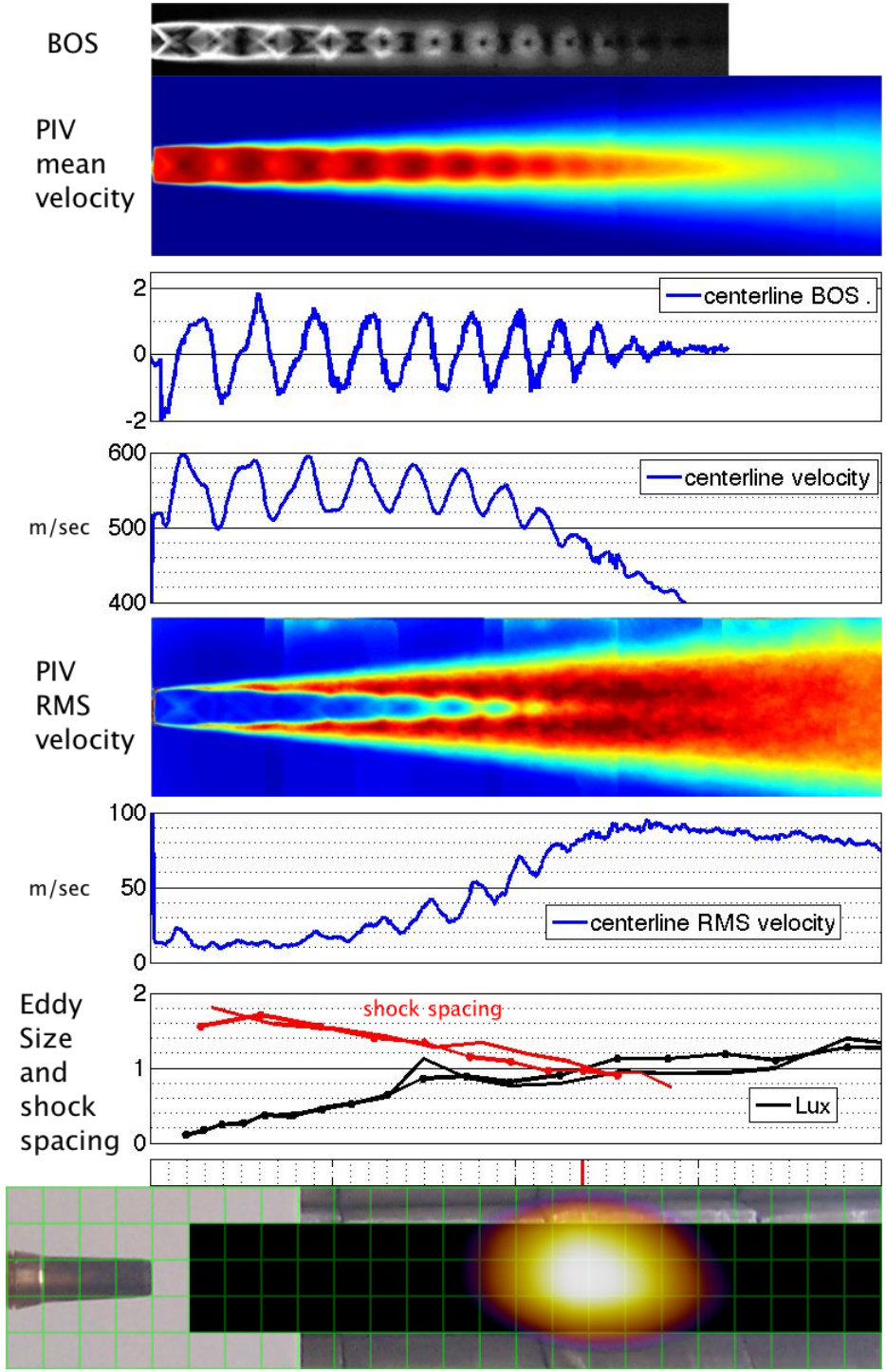

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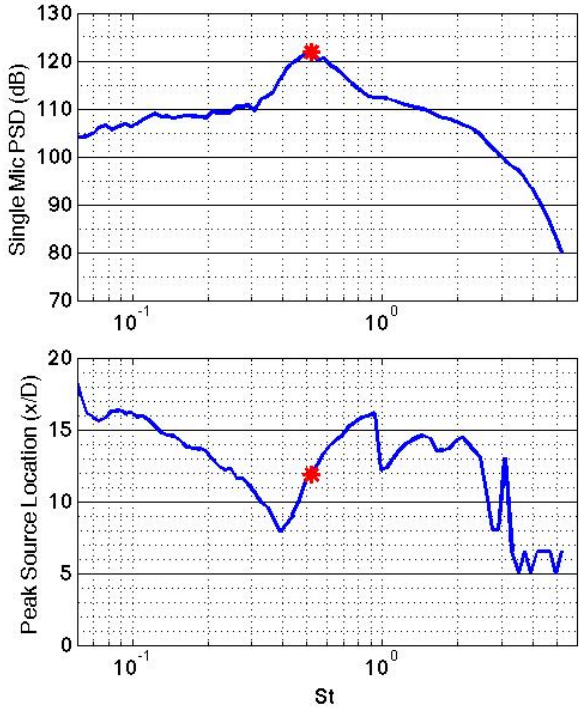

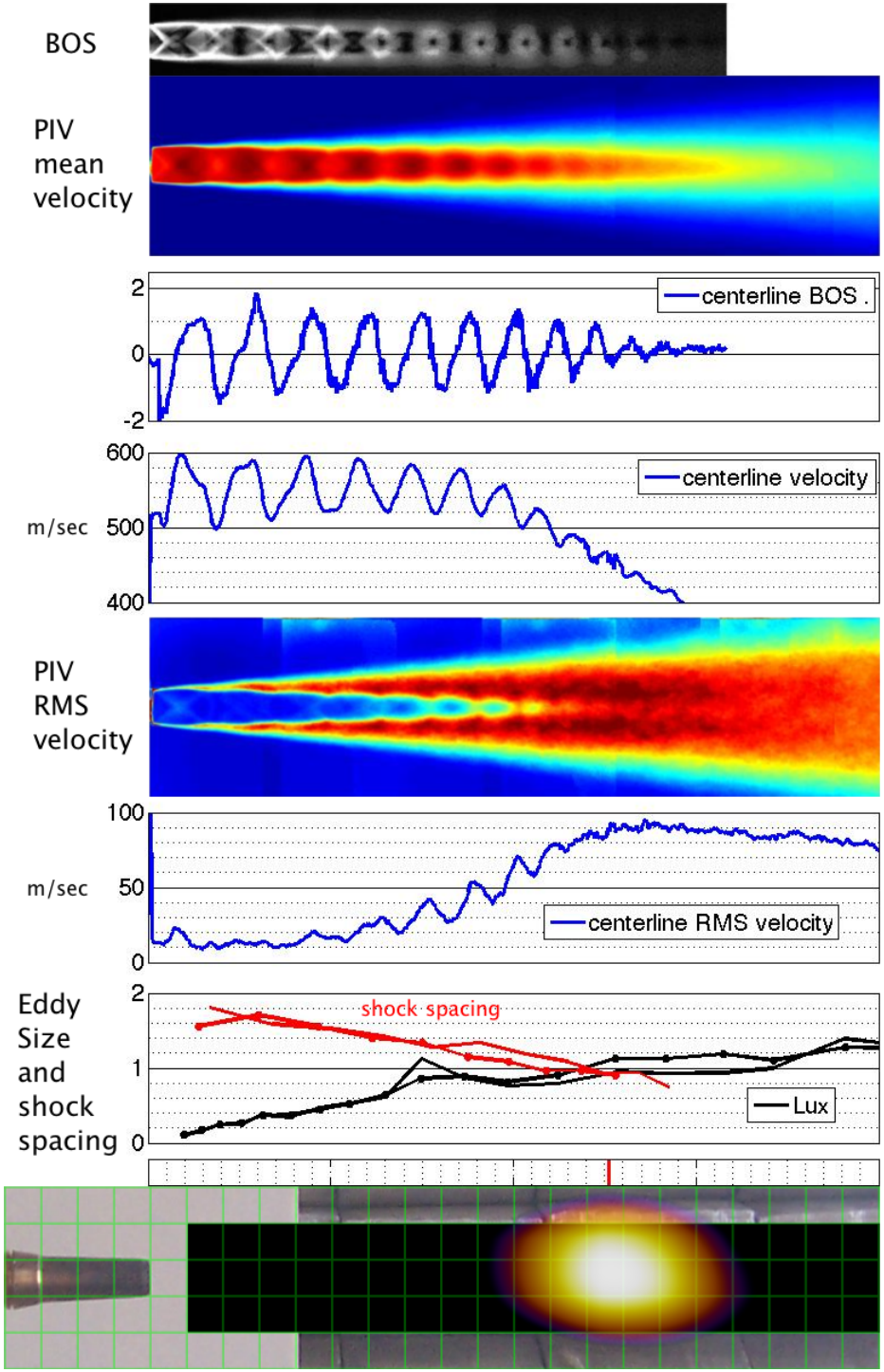

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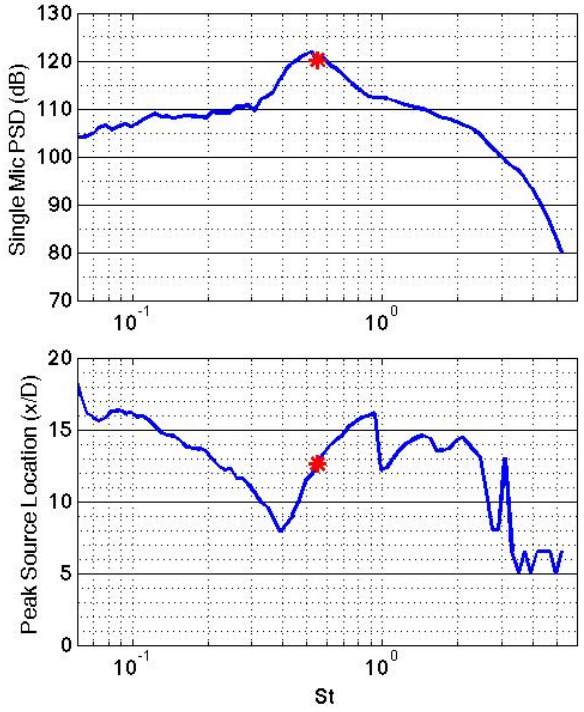

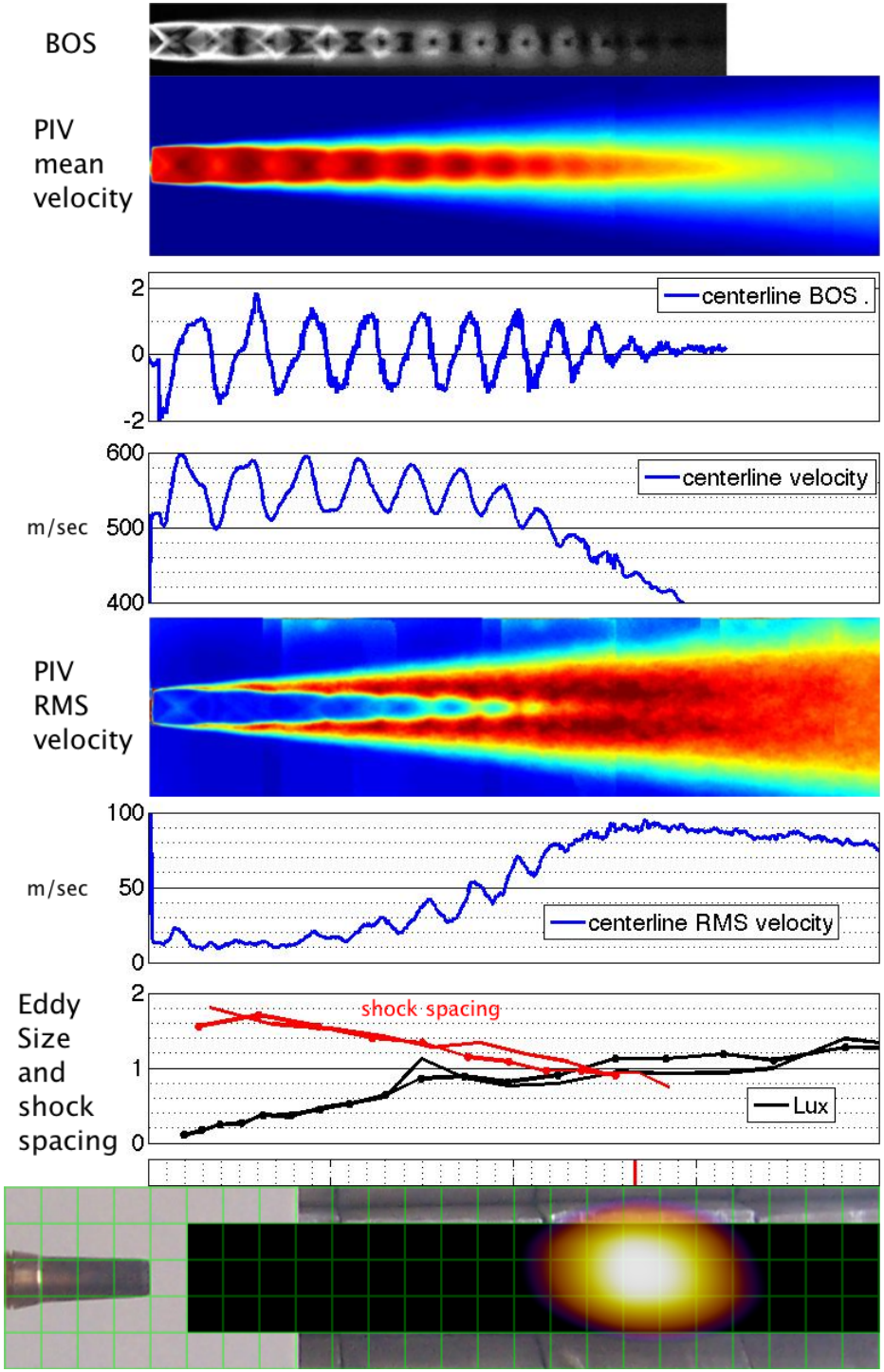

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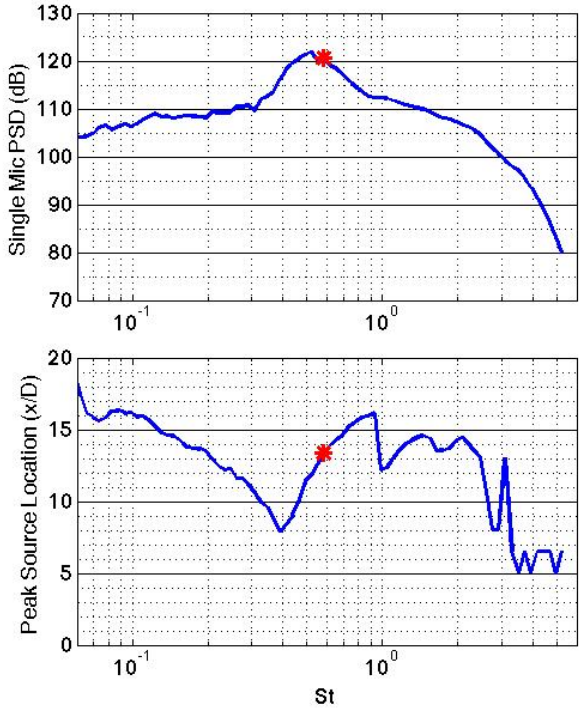

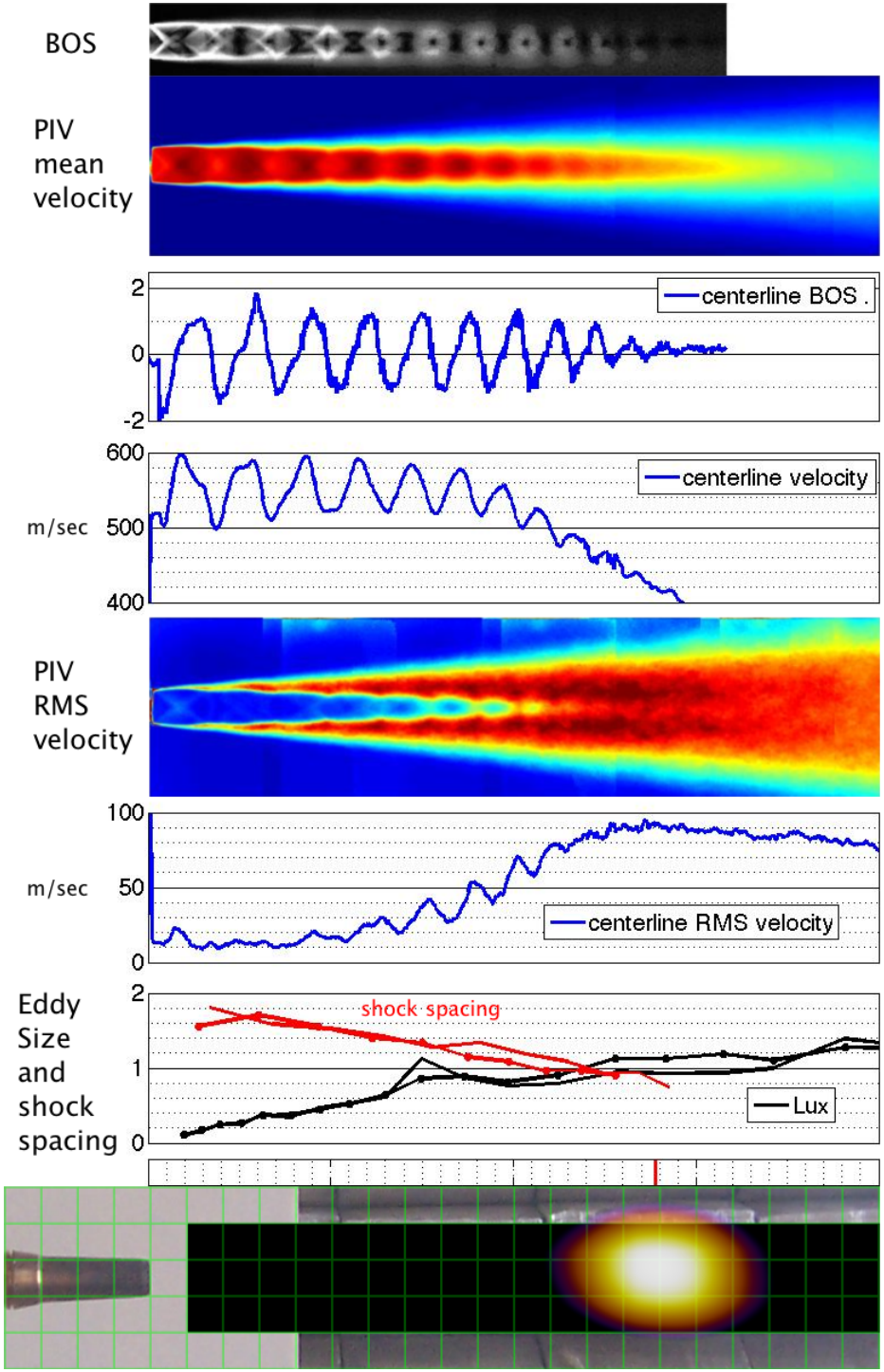

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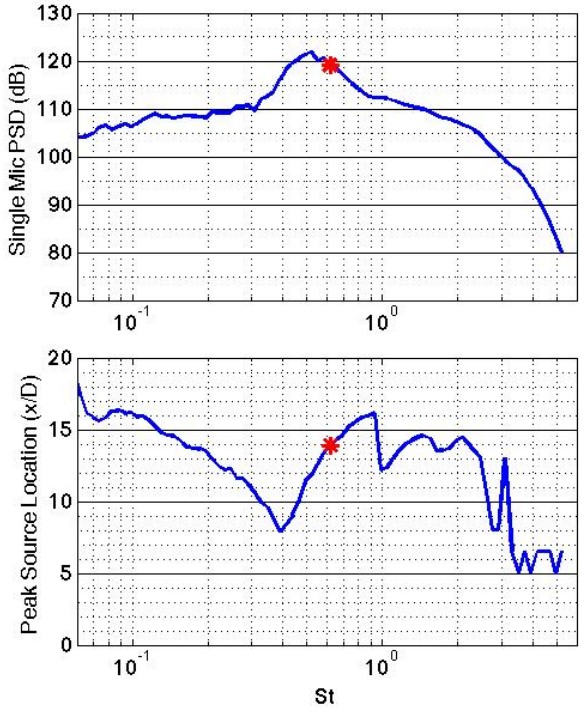

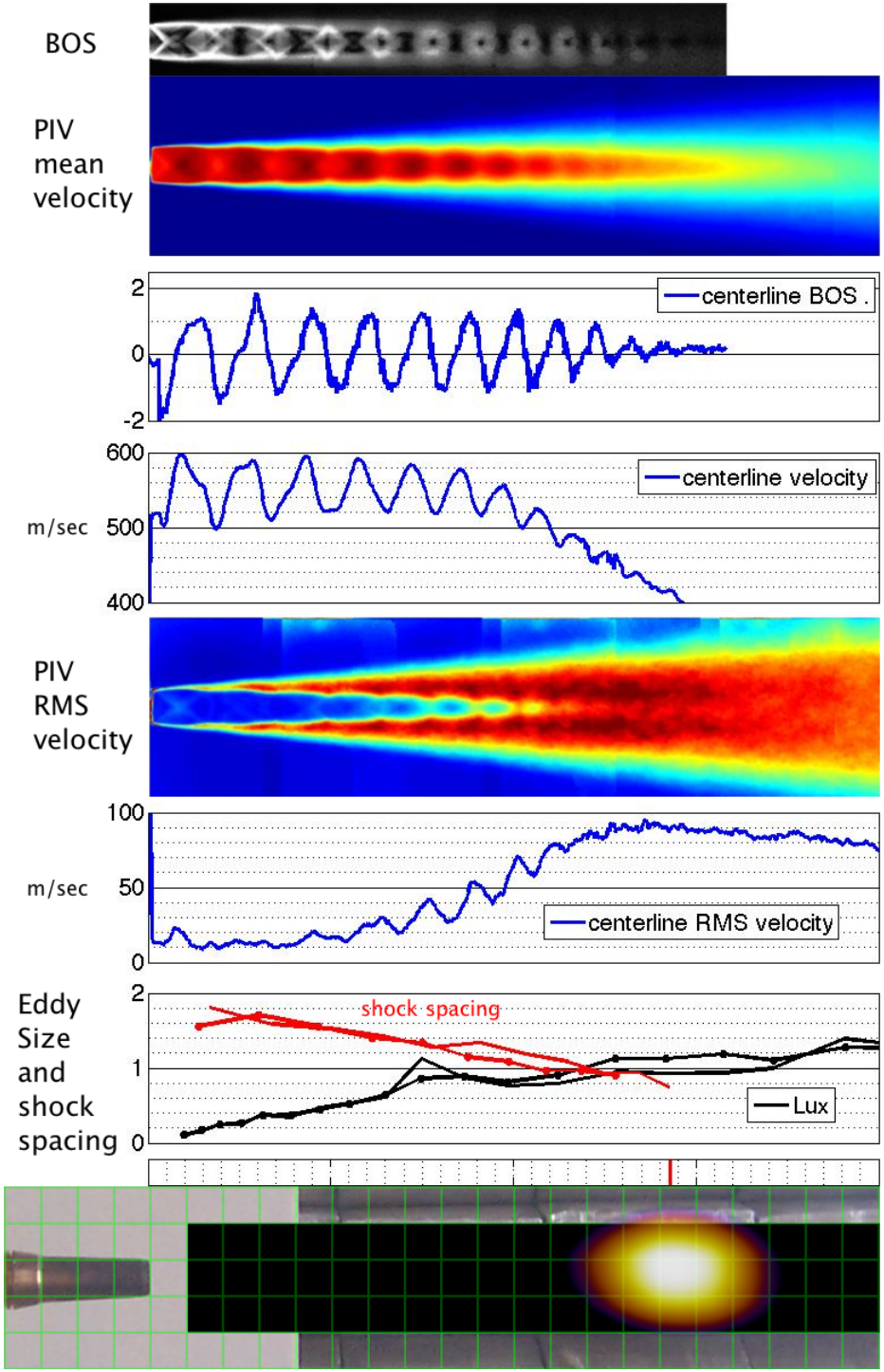

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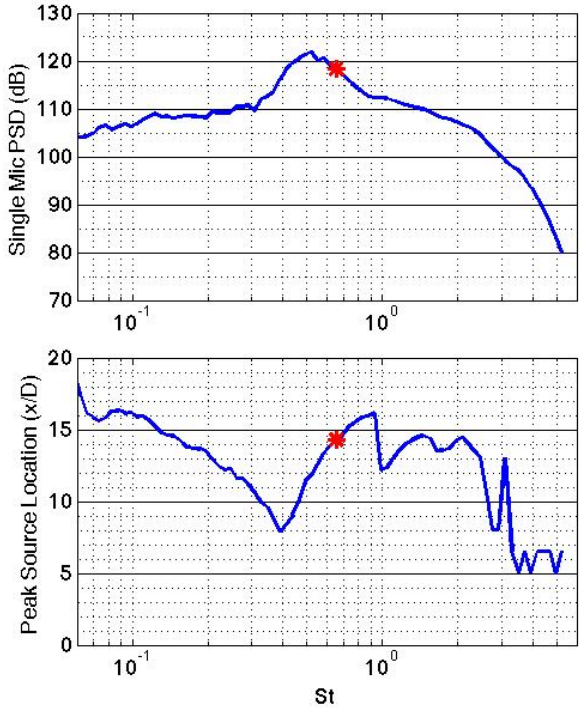

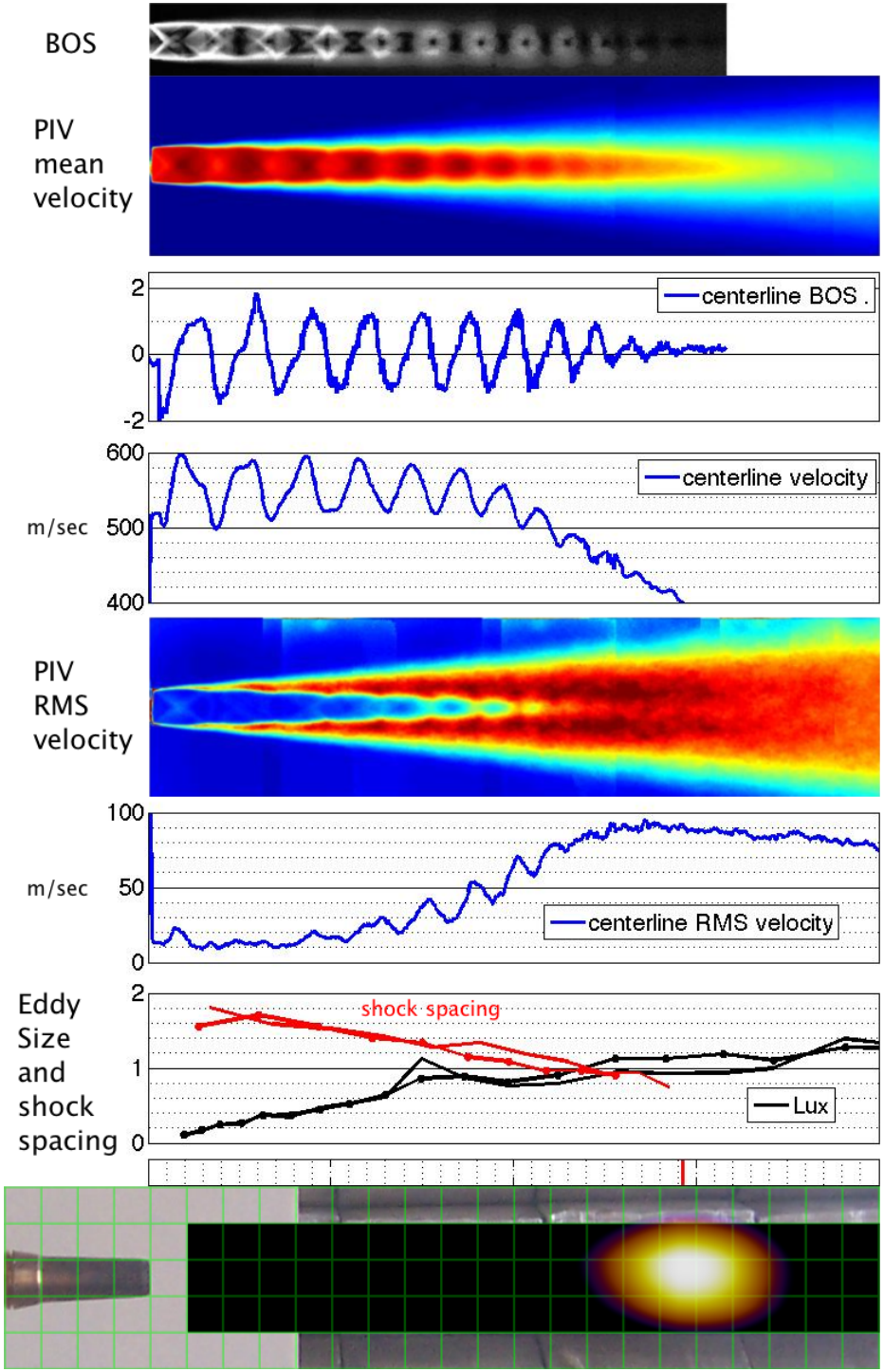

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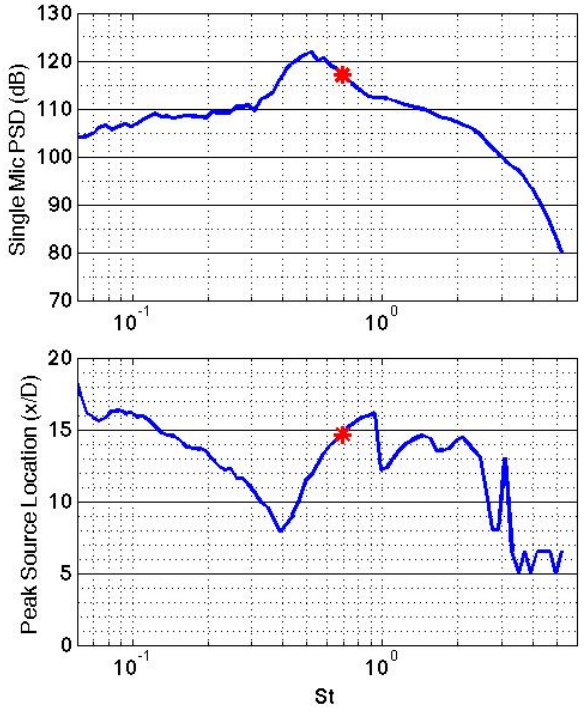

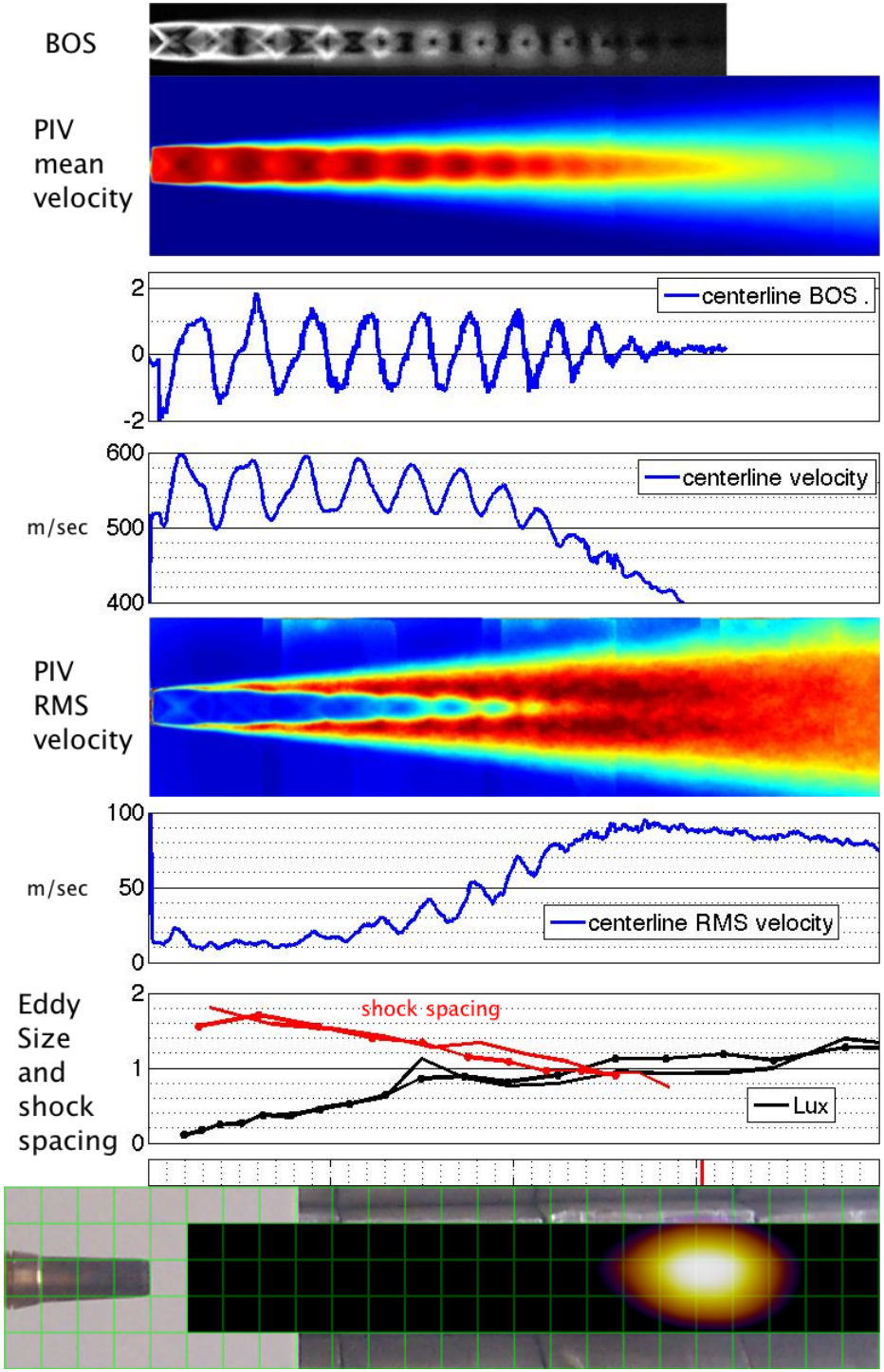

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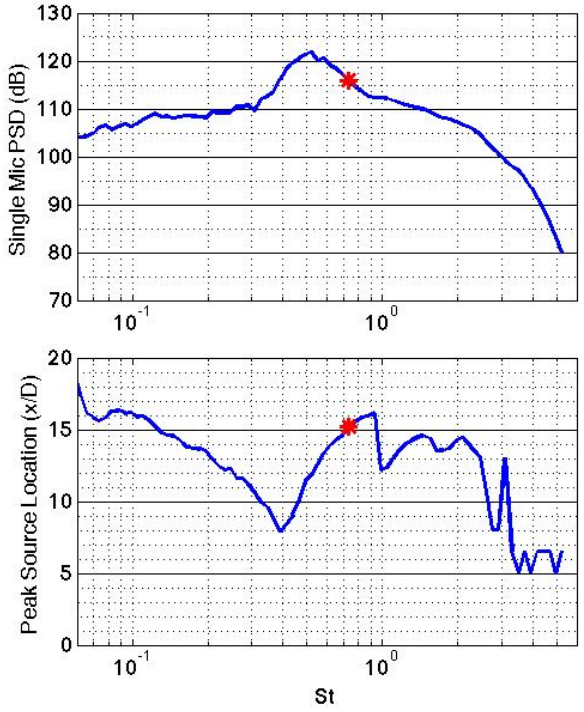

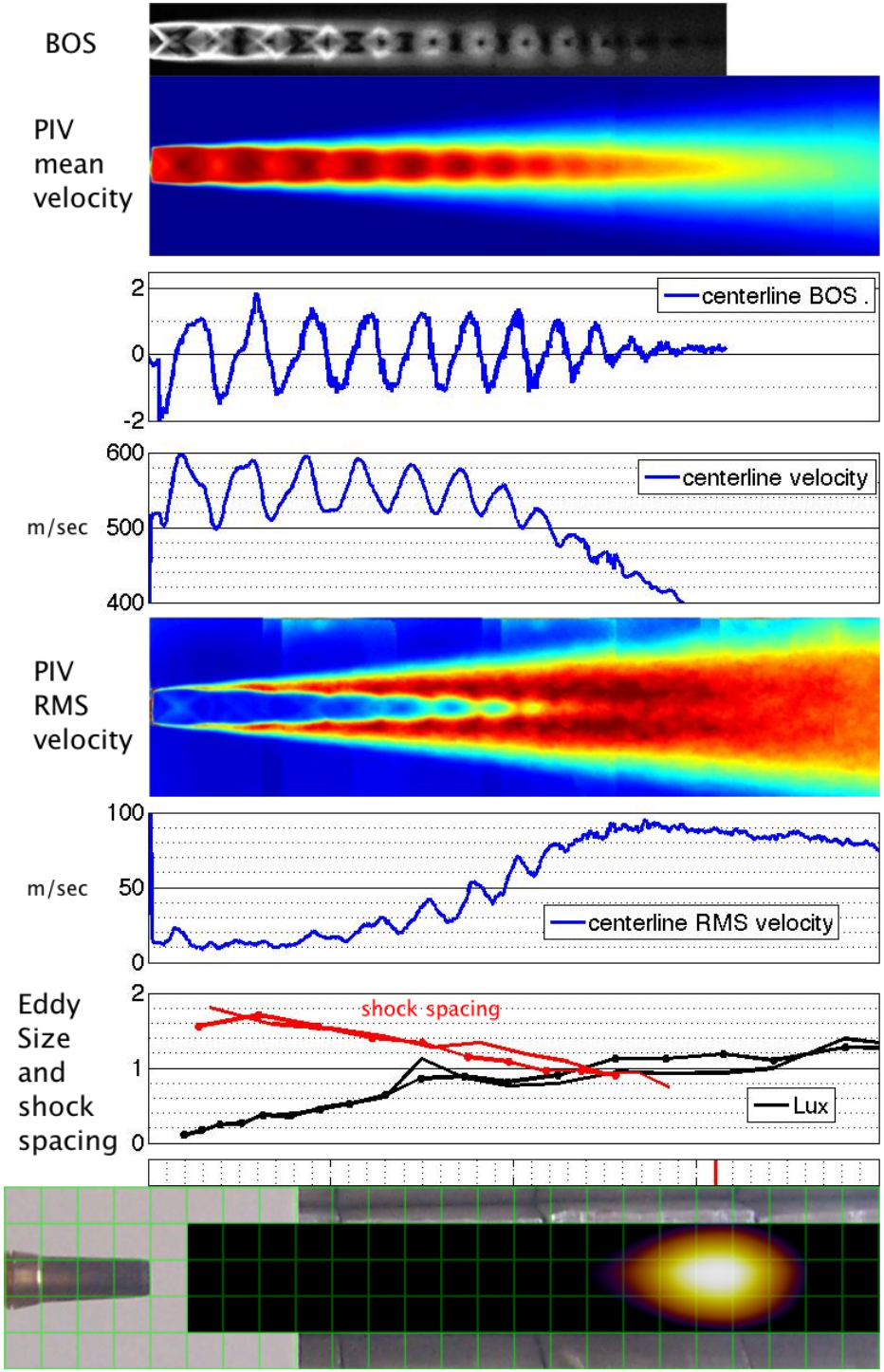

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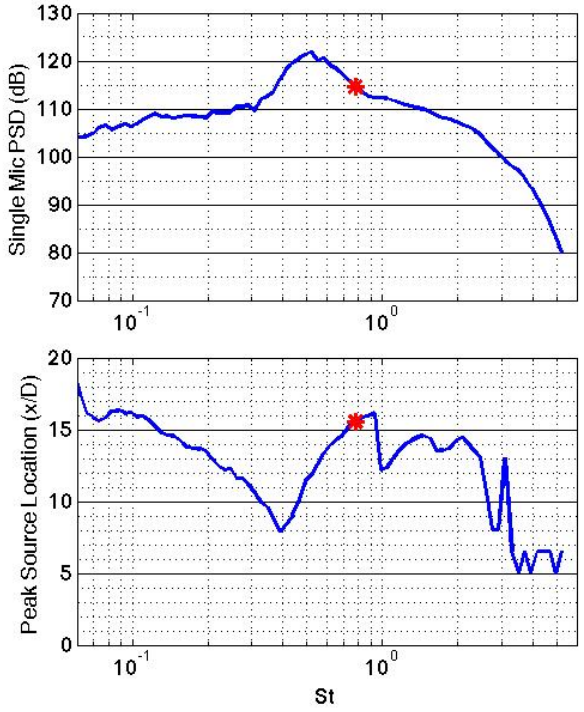

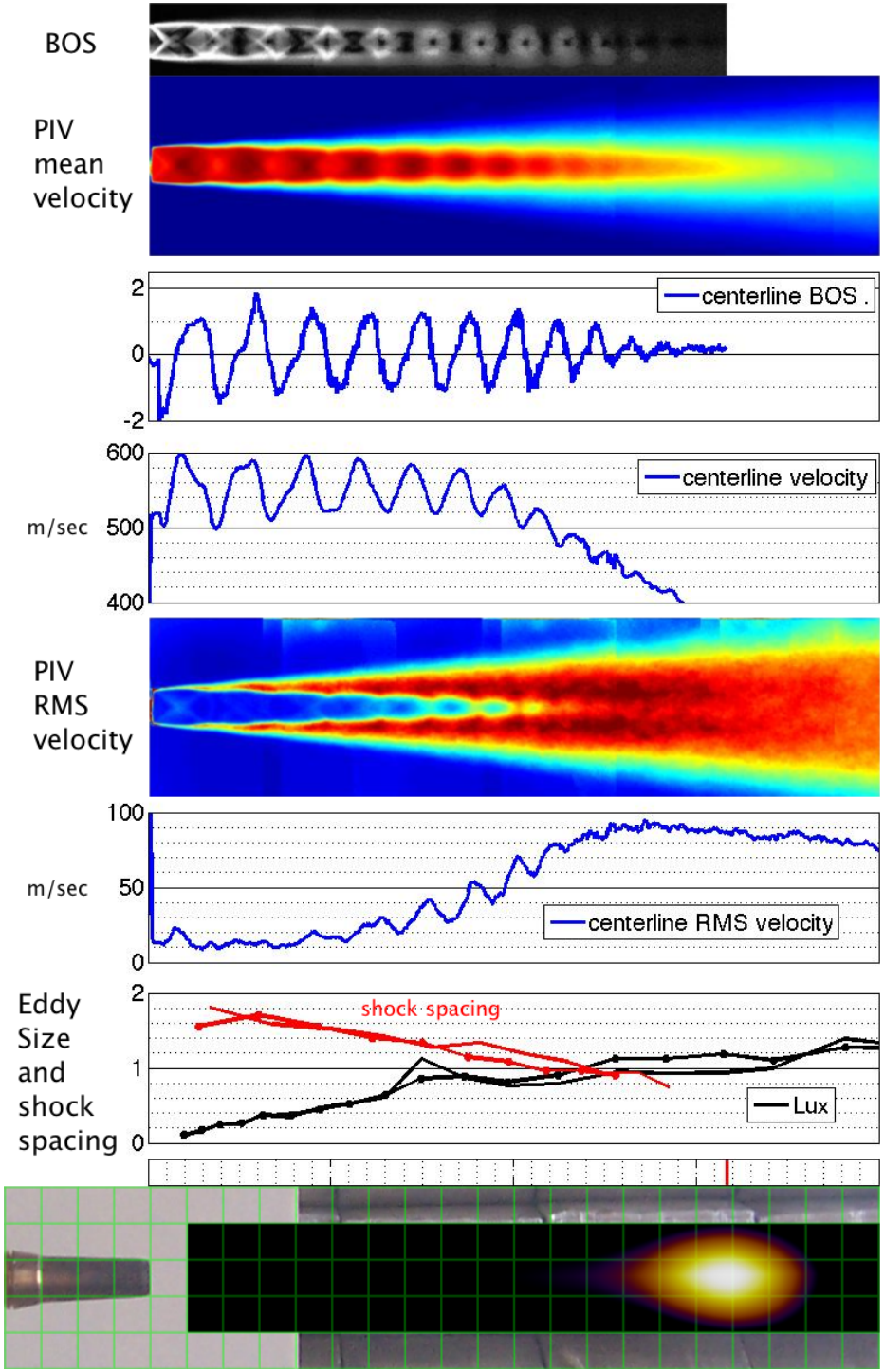

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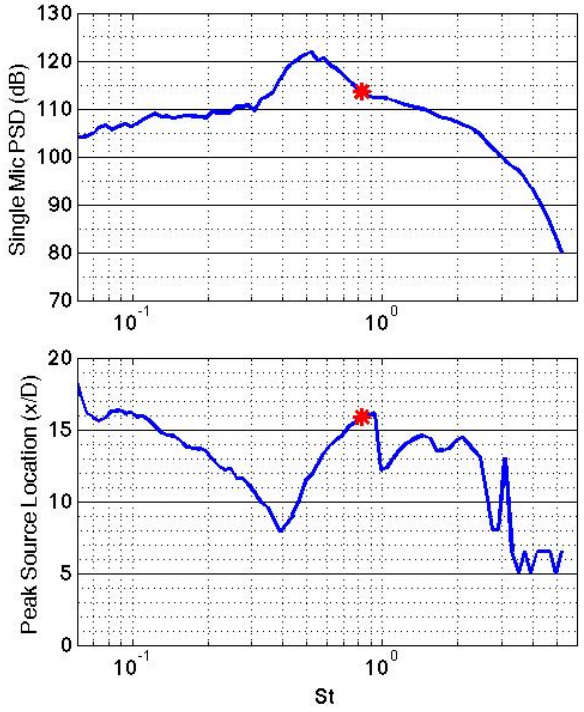

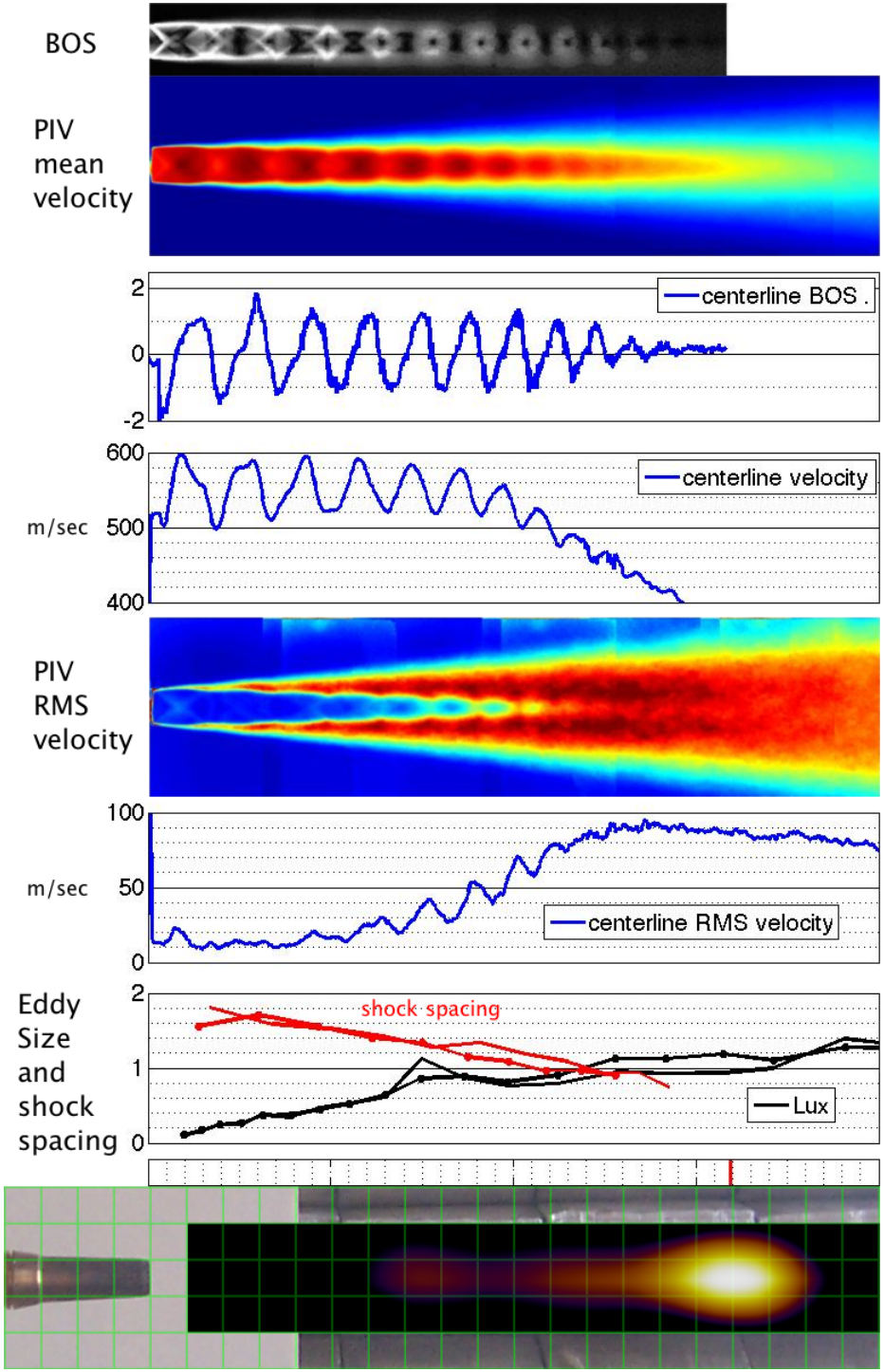

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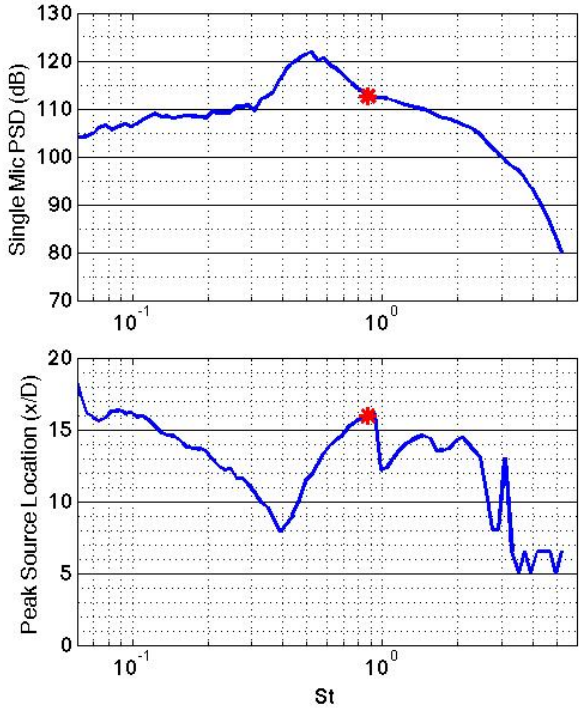

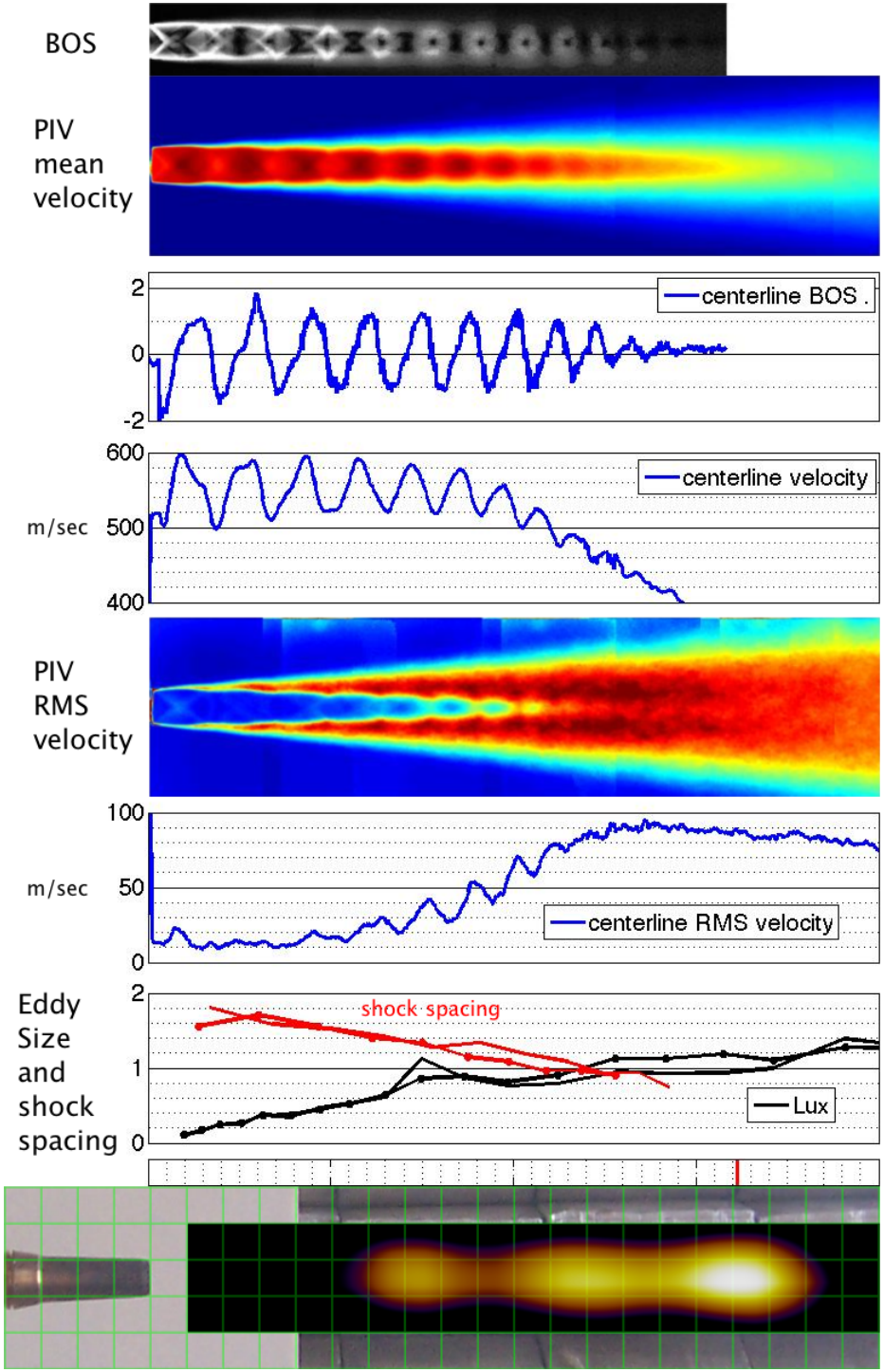

SMC016

under-expanded

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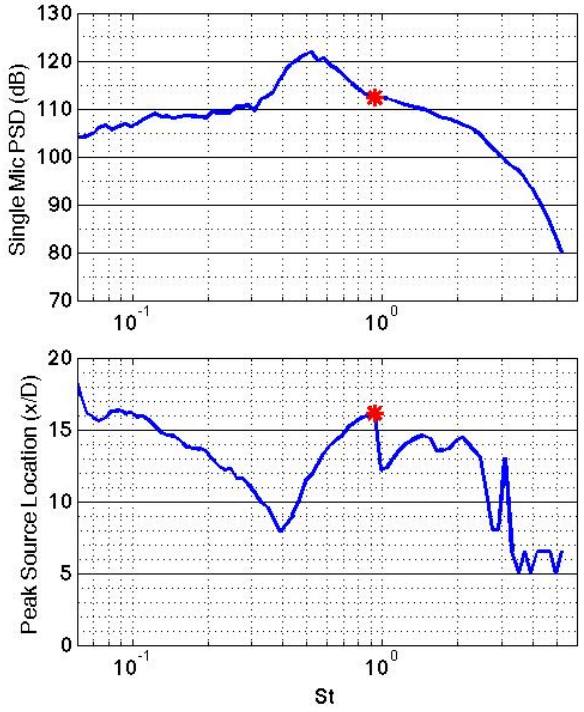

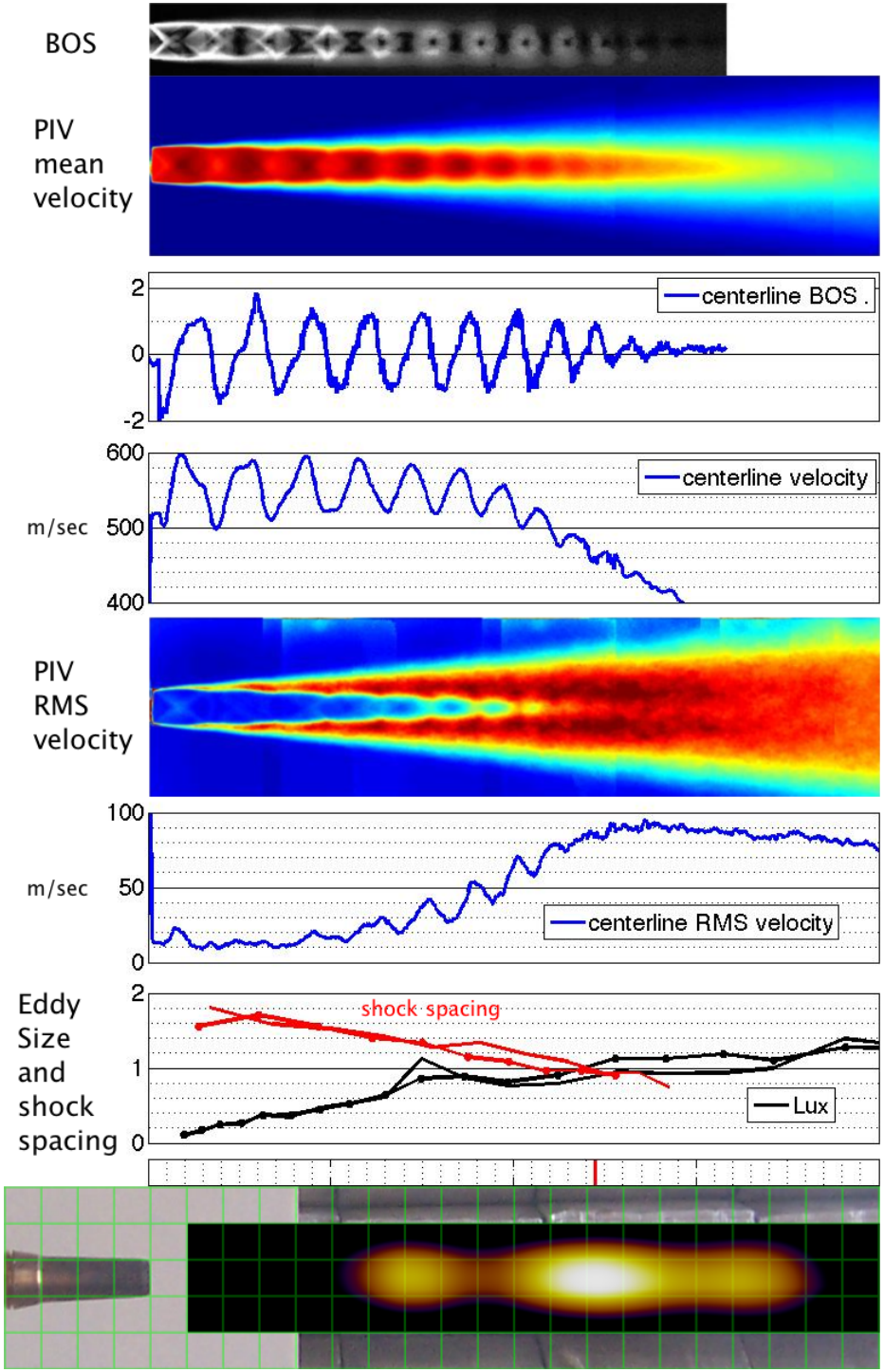

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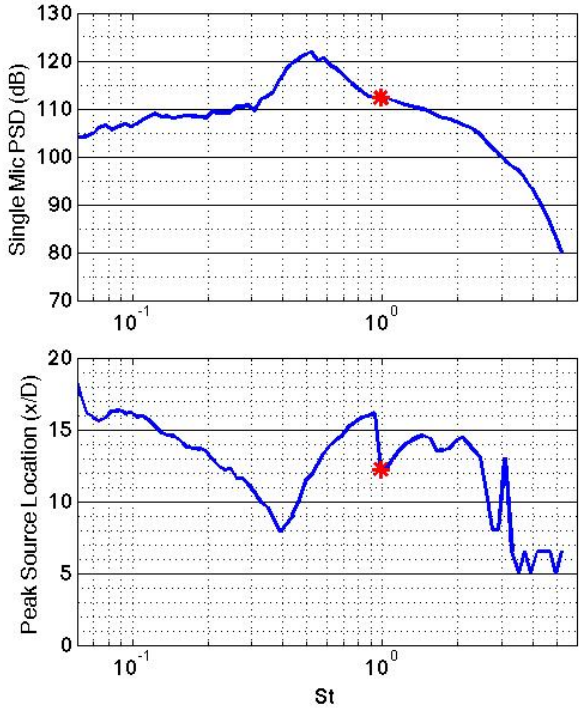

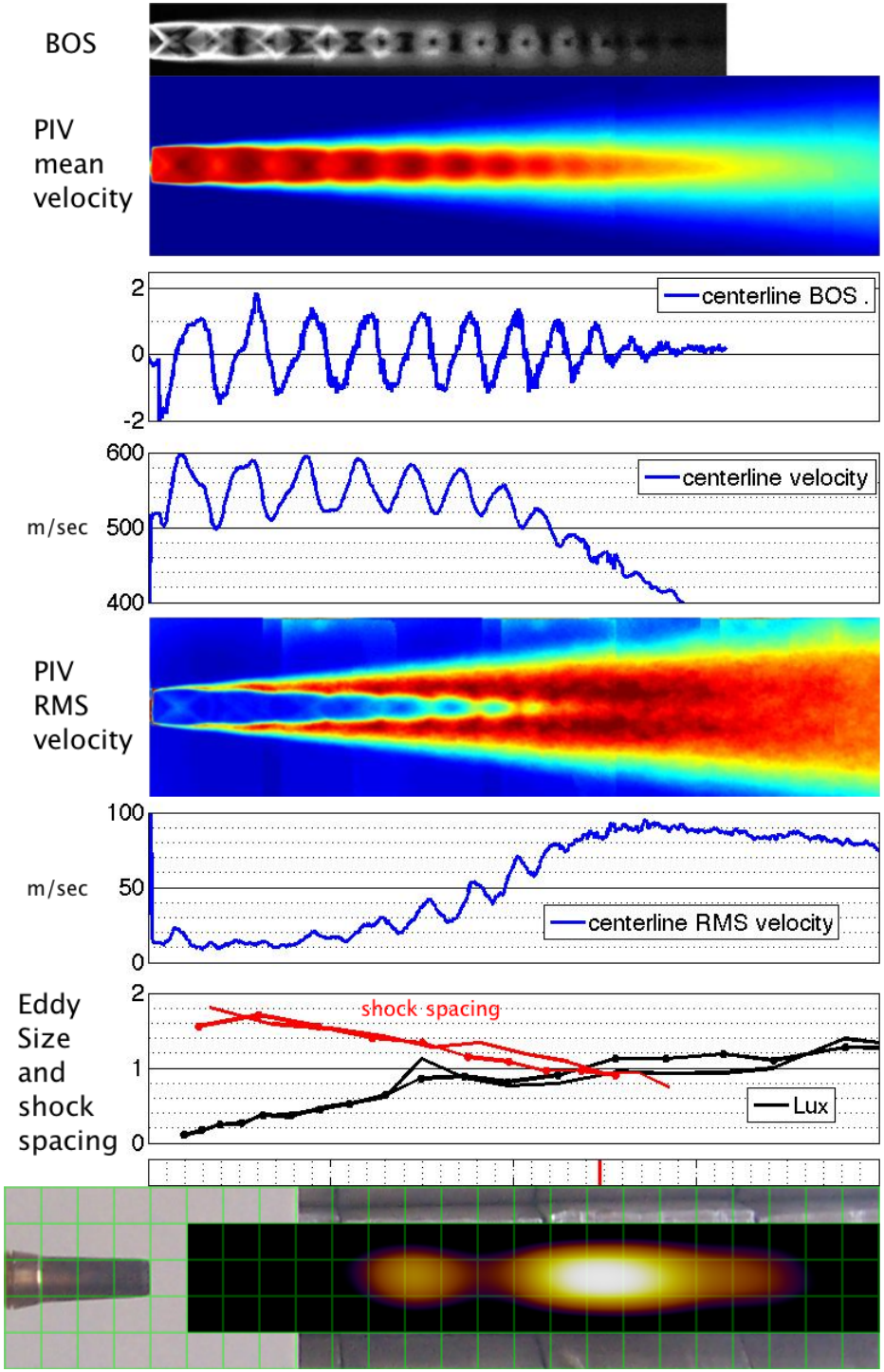

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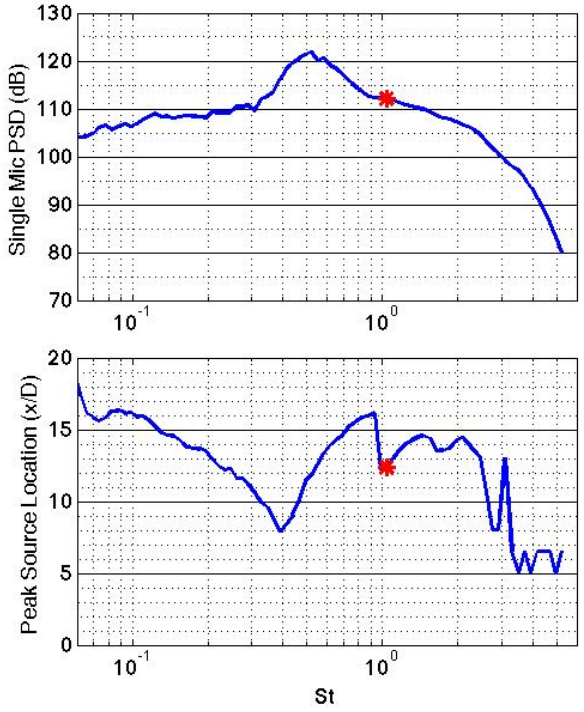

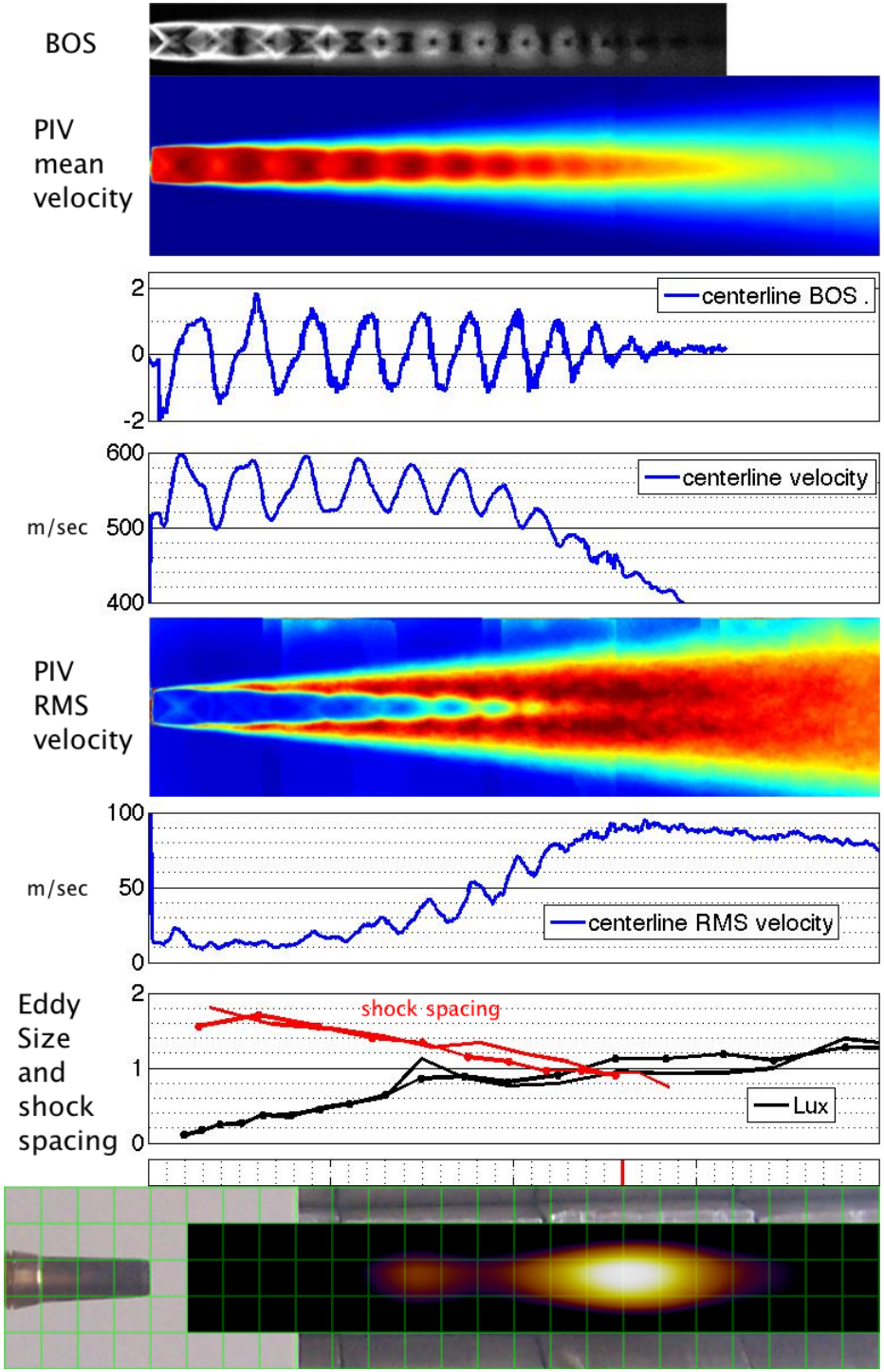

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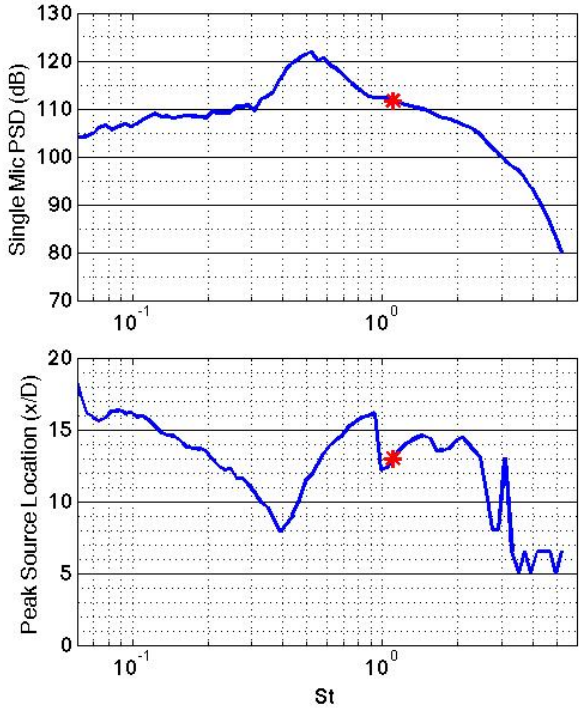

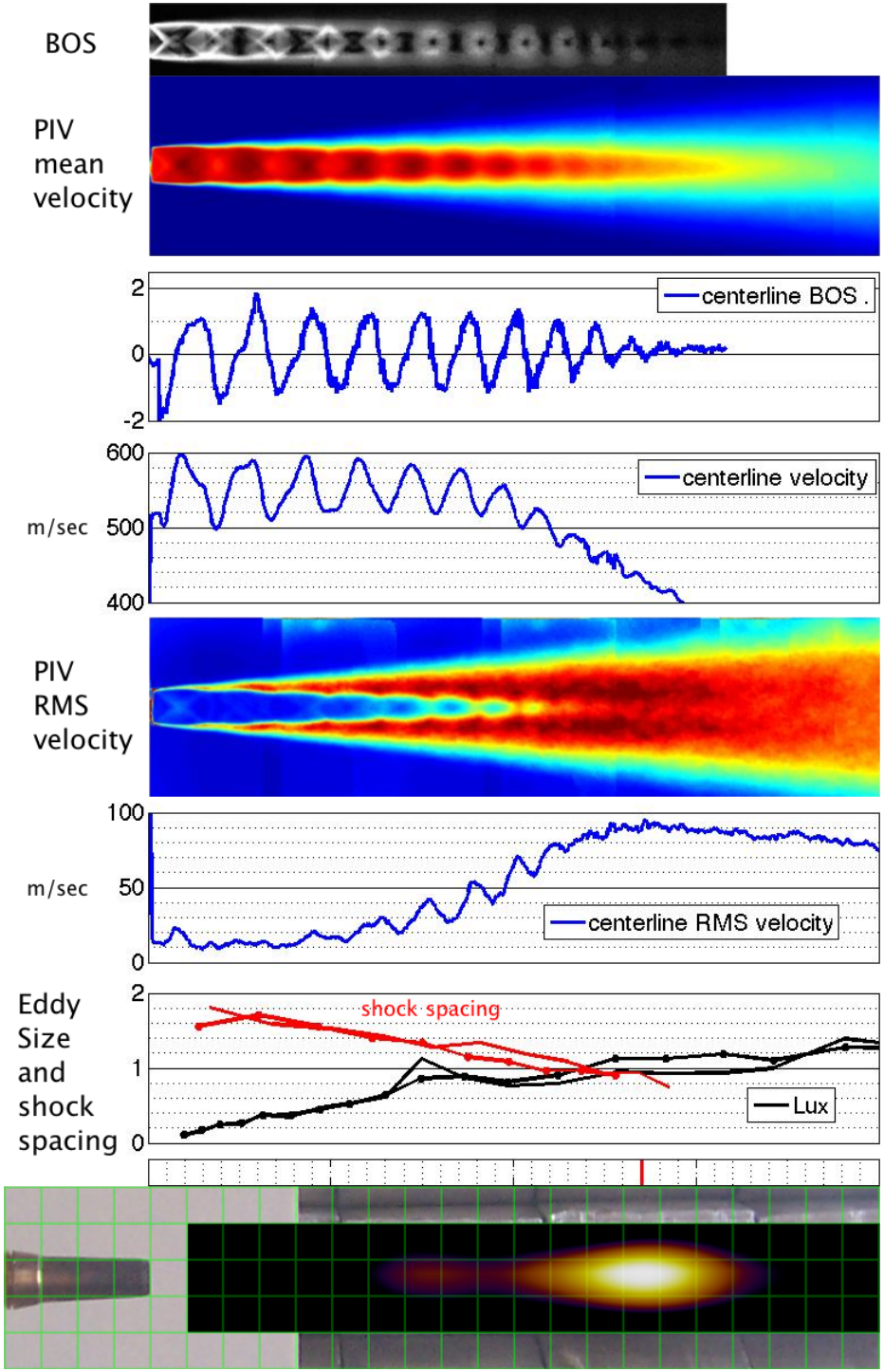

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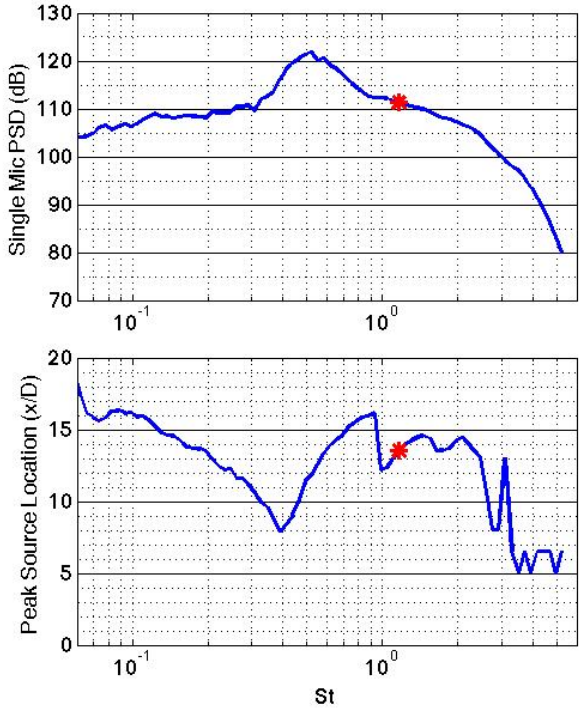

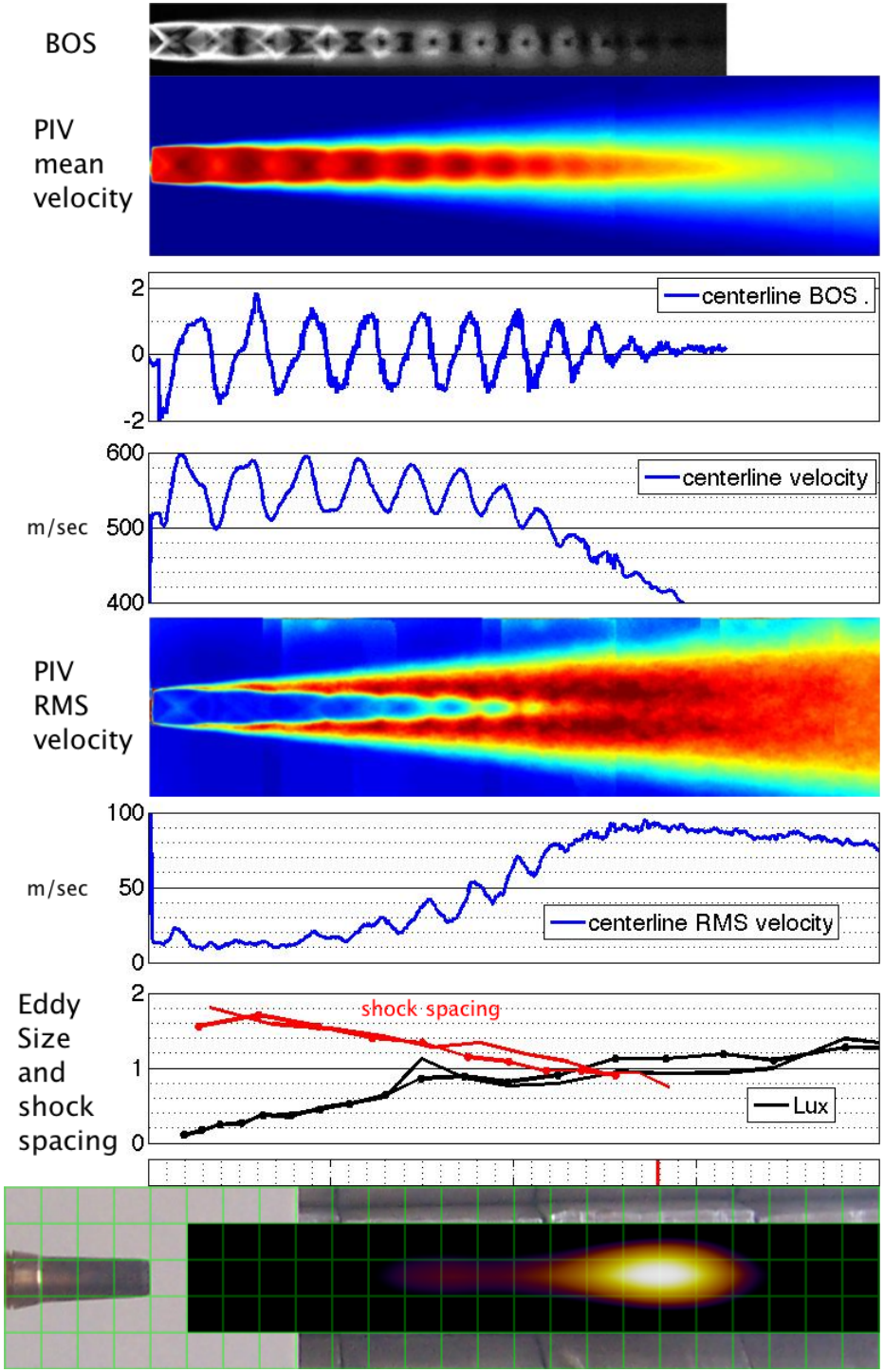

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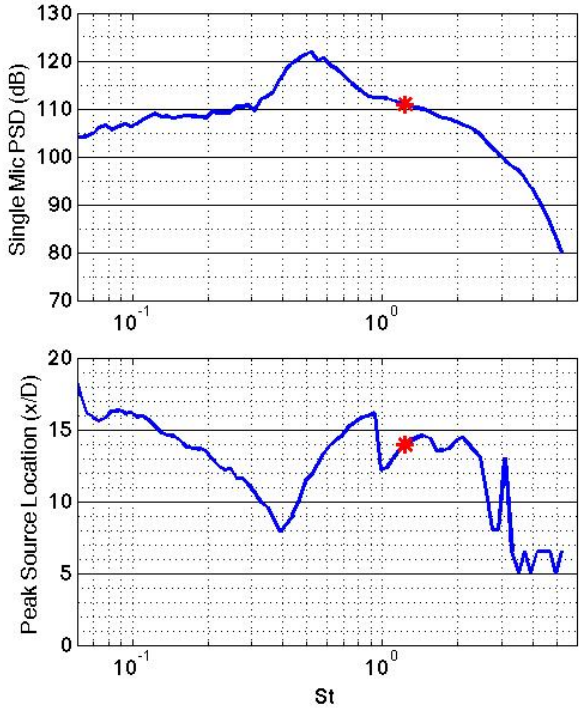

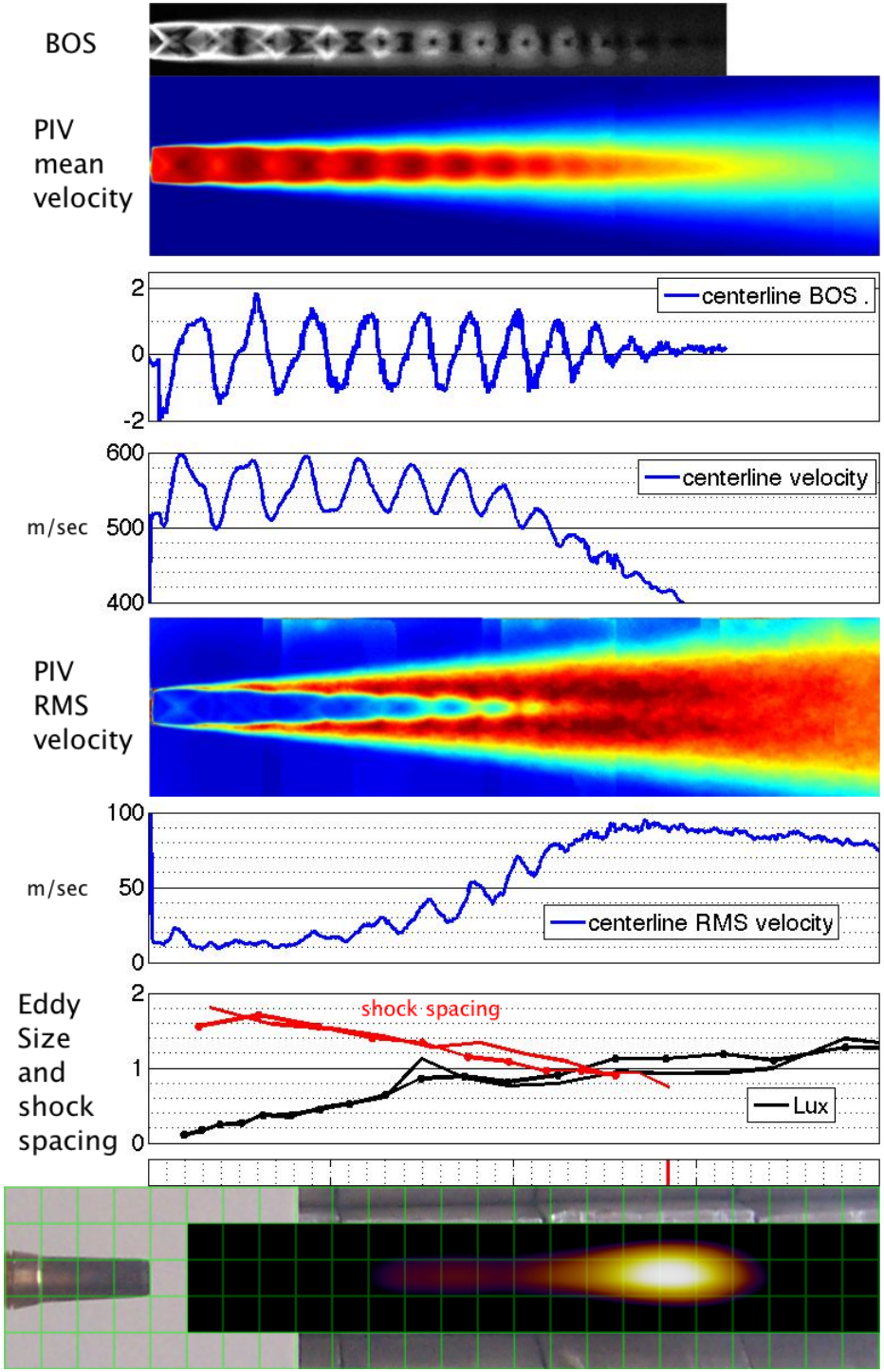

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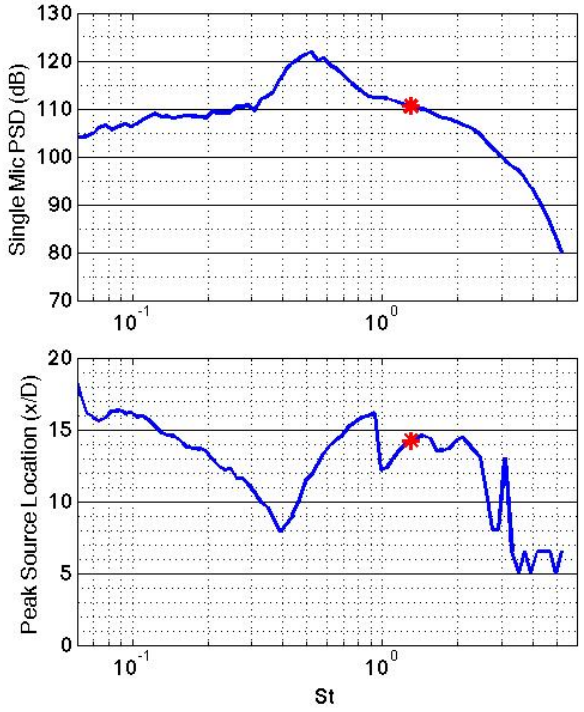

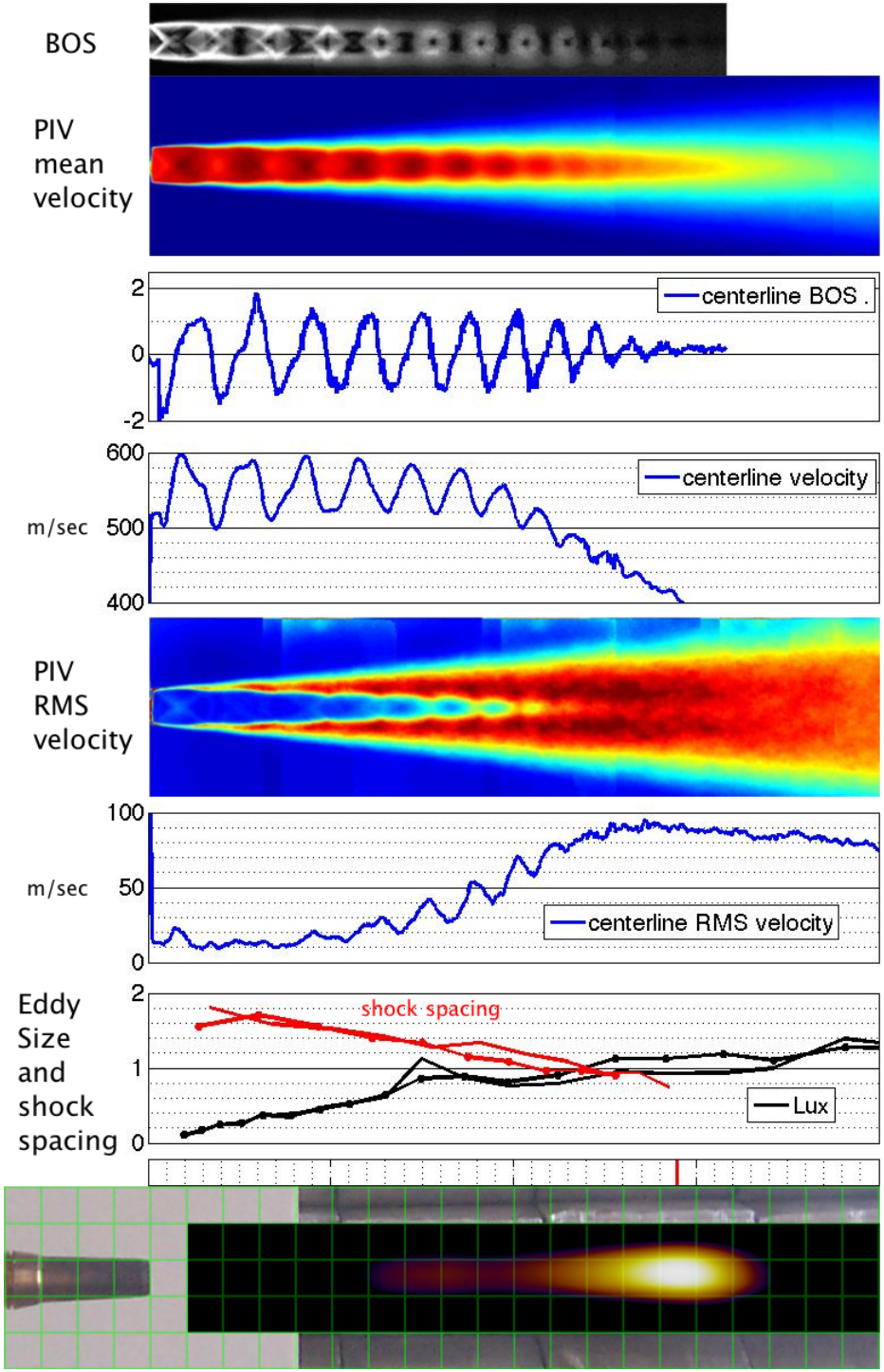

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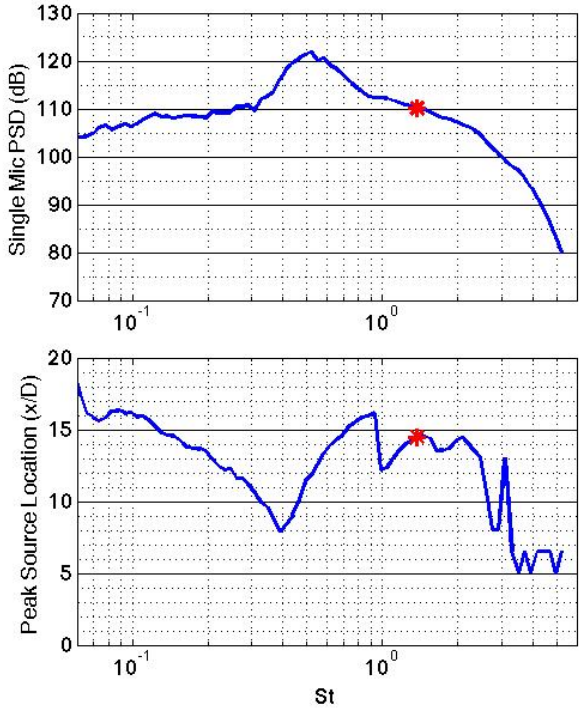

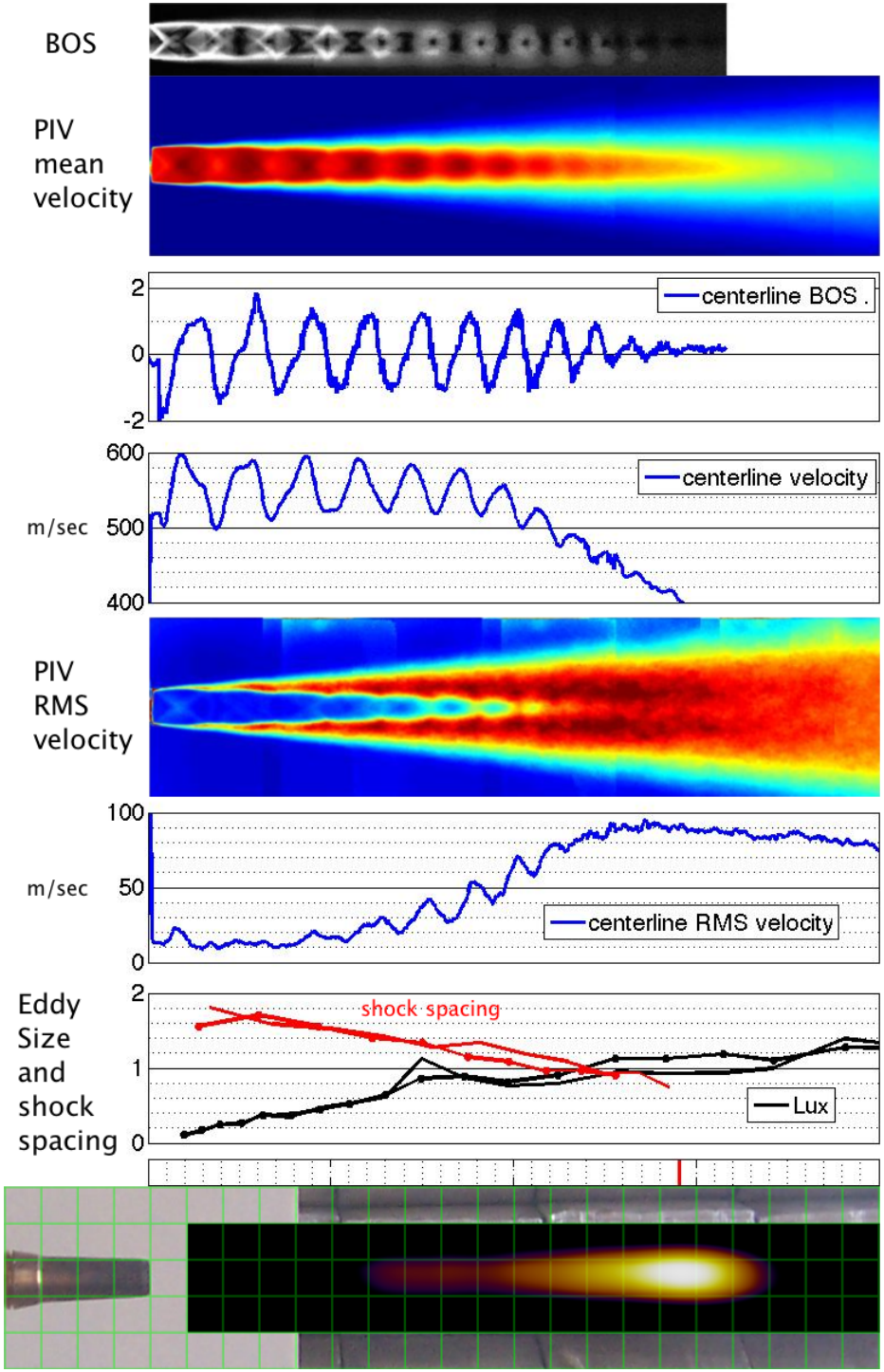

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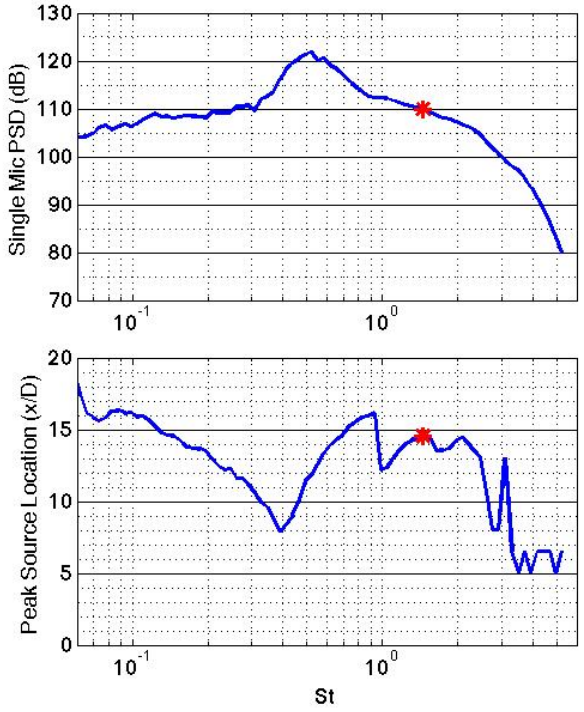

SMC016 convergent-divergent

over-expanded

set point 11606

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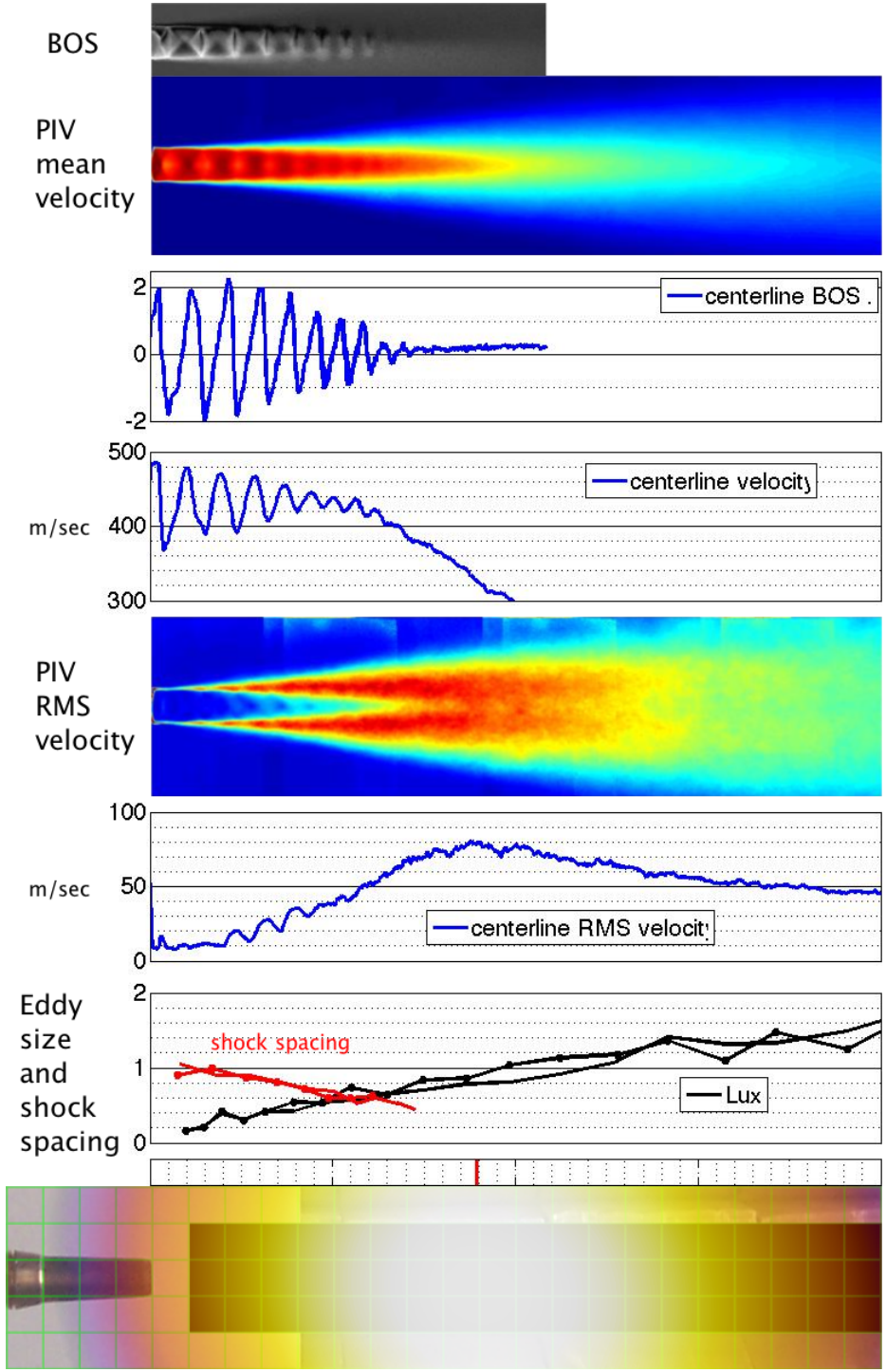

SMC016

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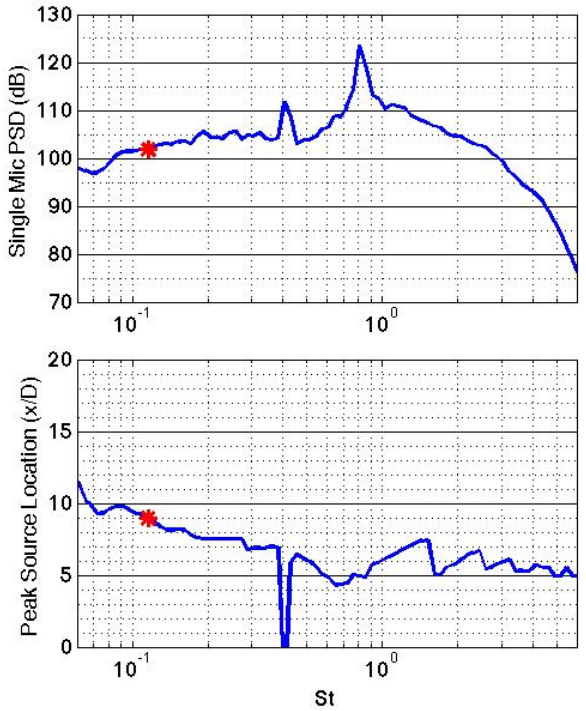

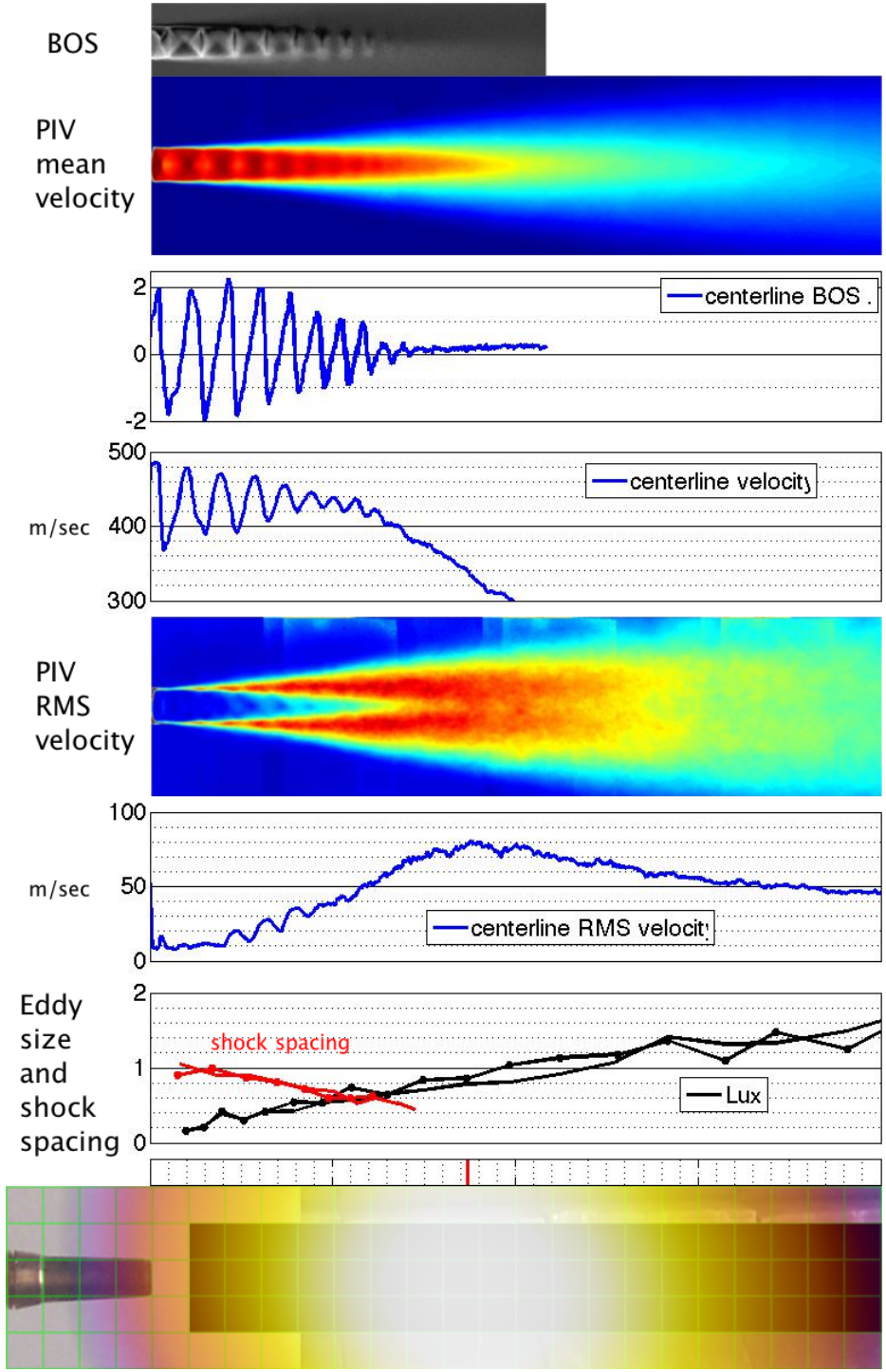

SMC016

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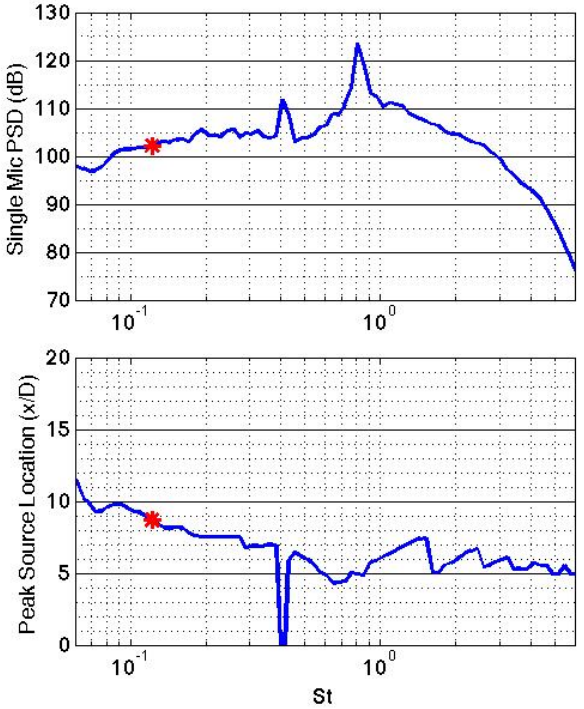

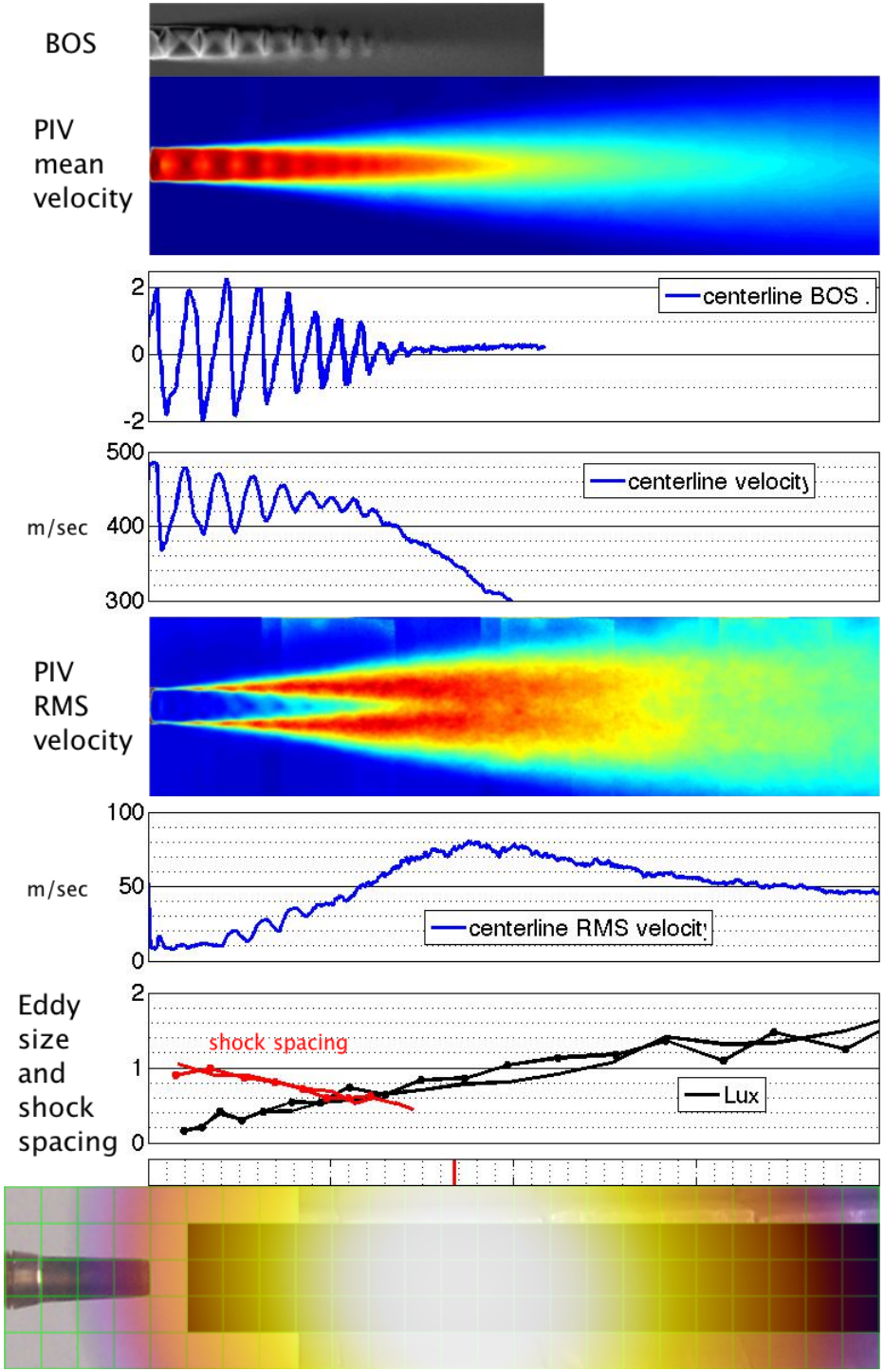

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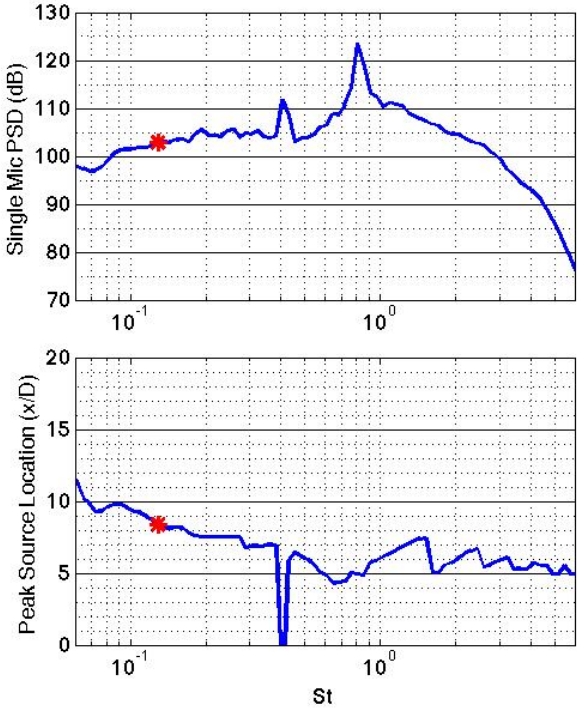

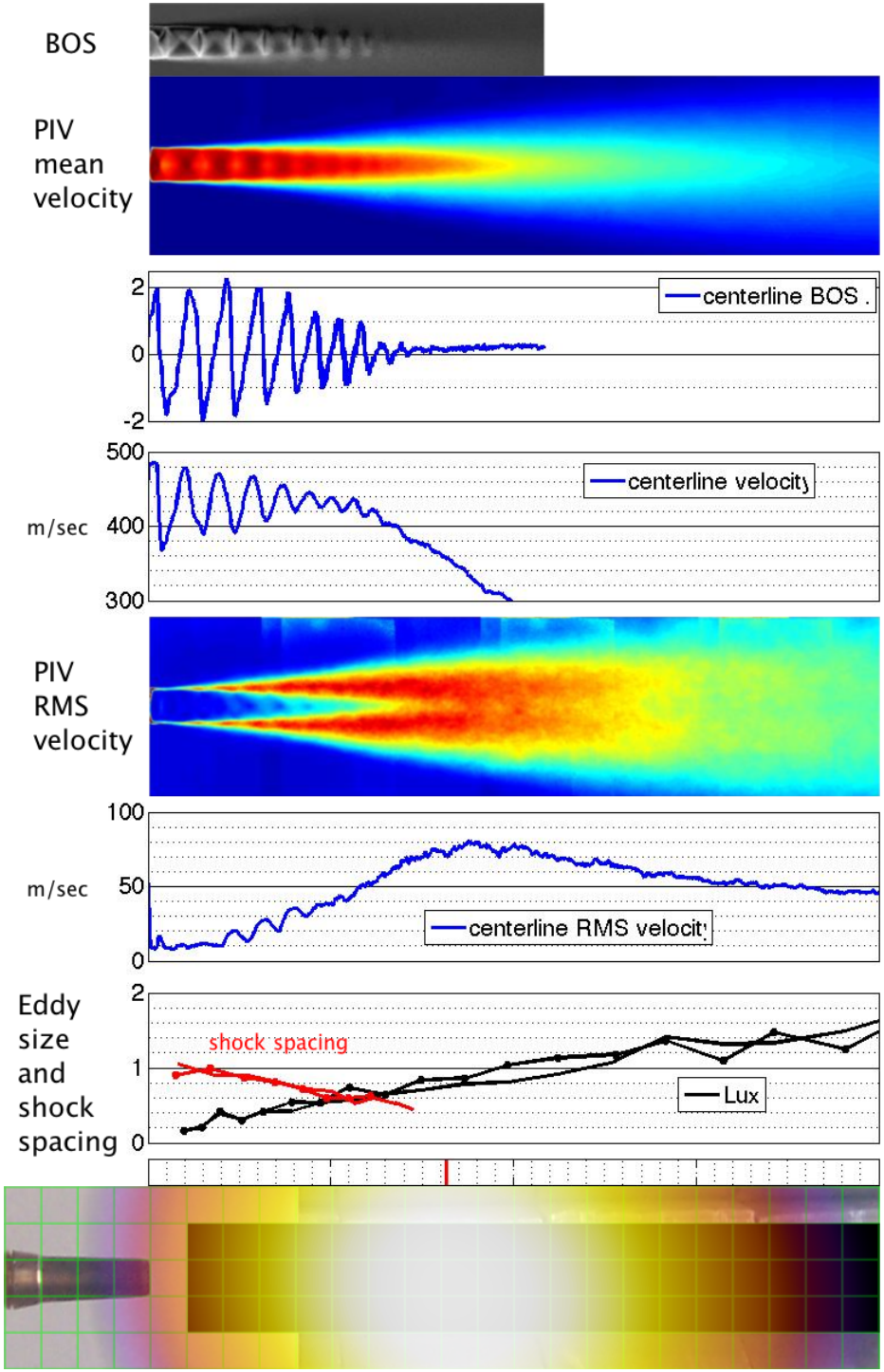

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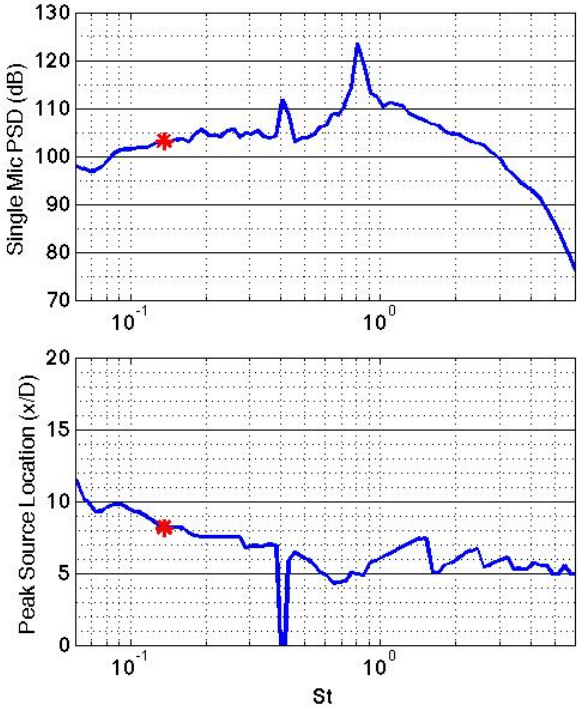

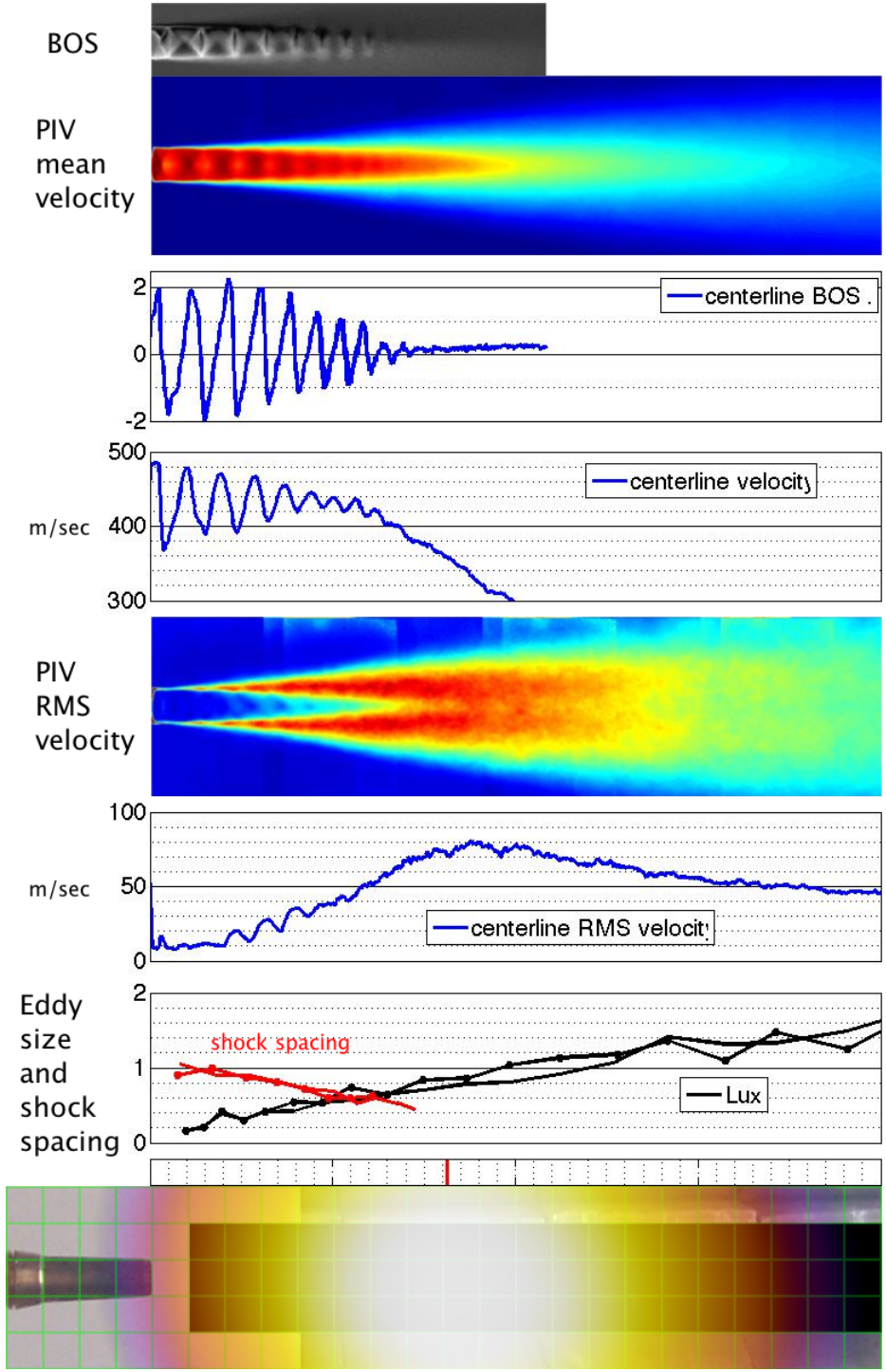

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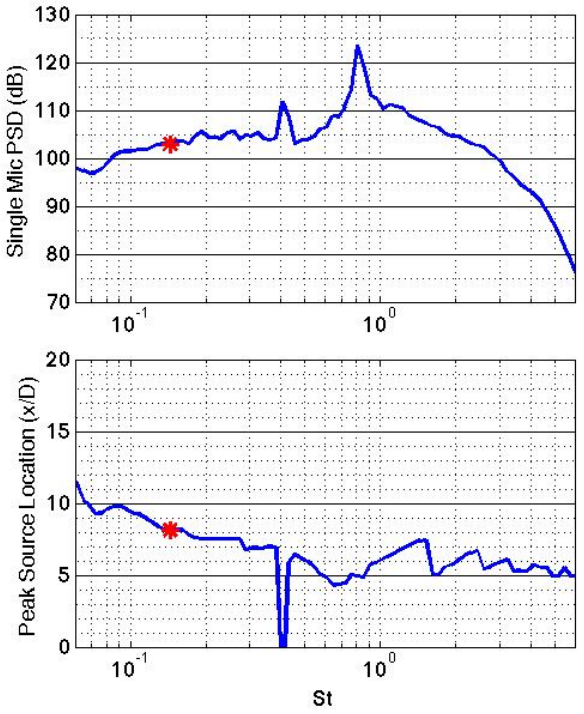

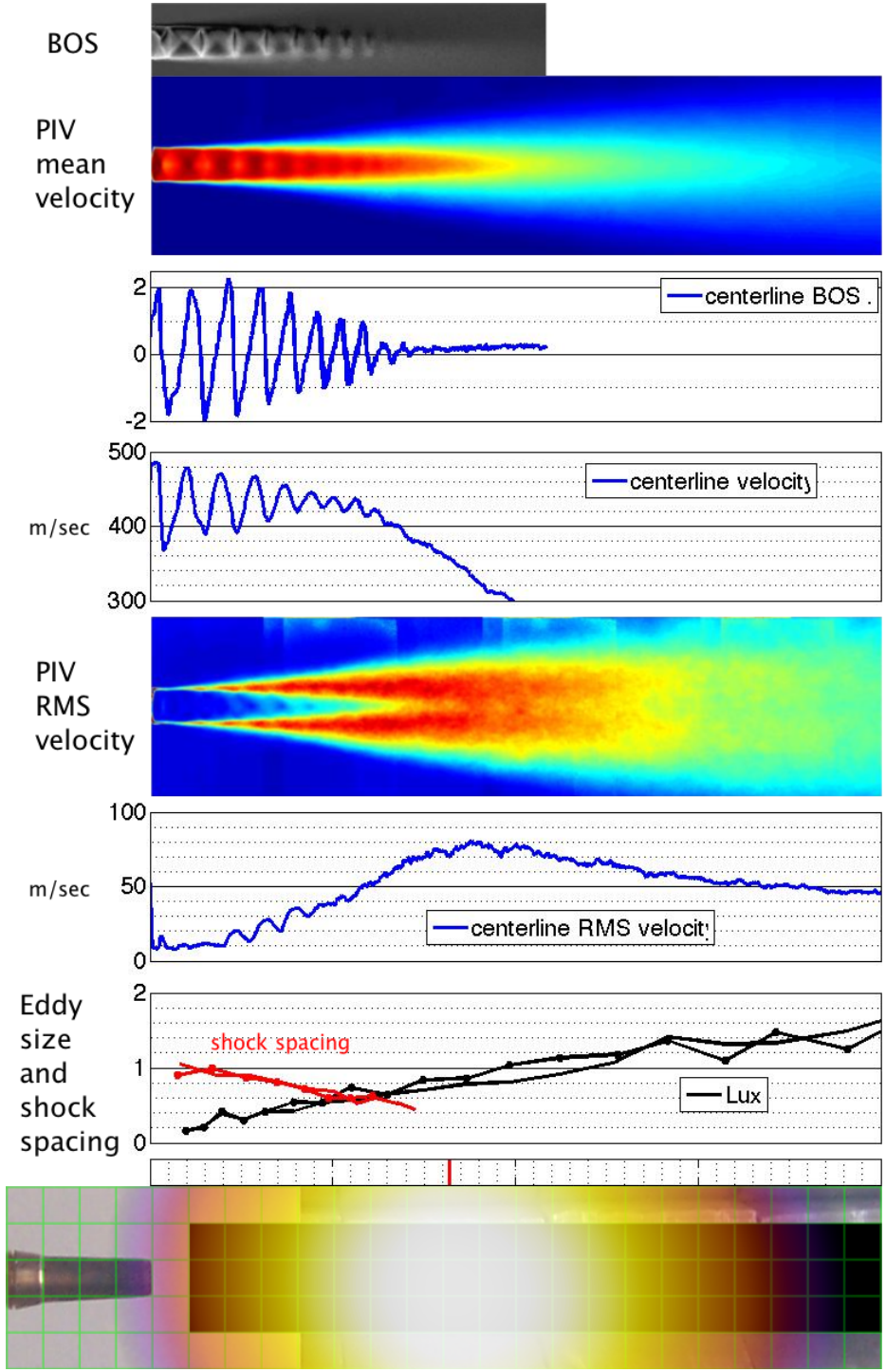

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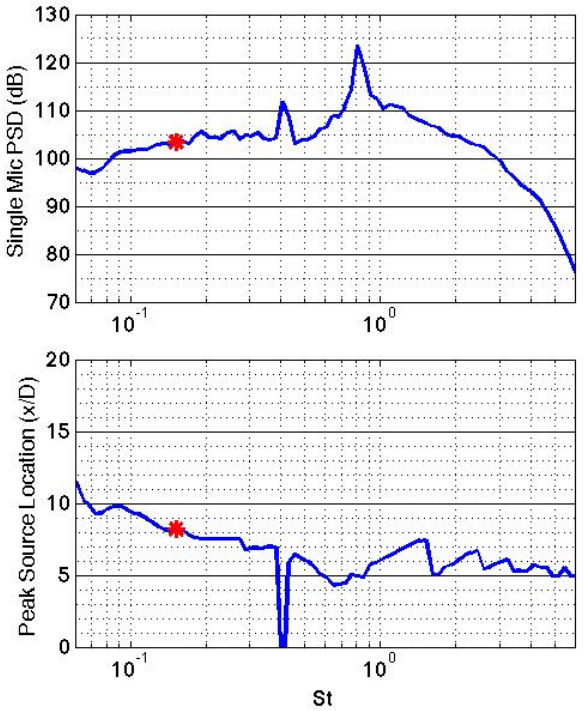

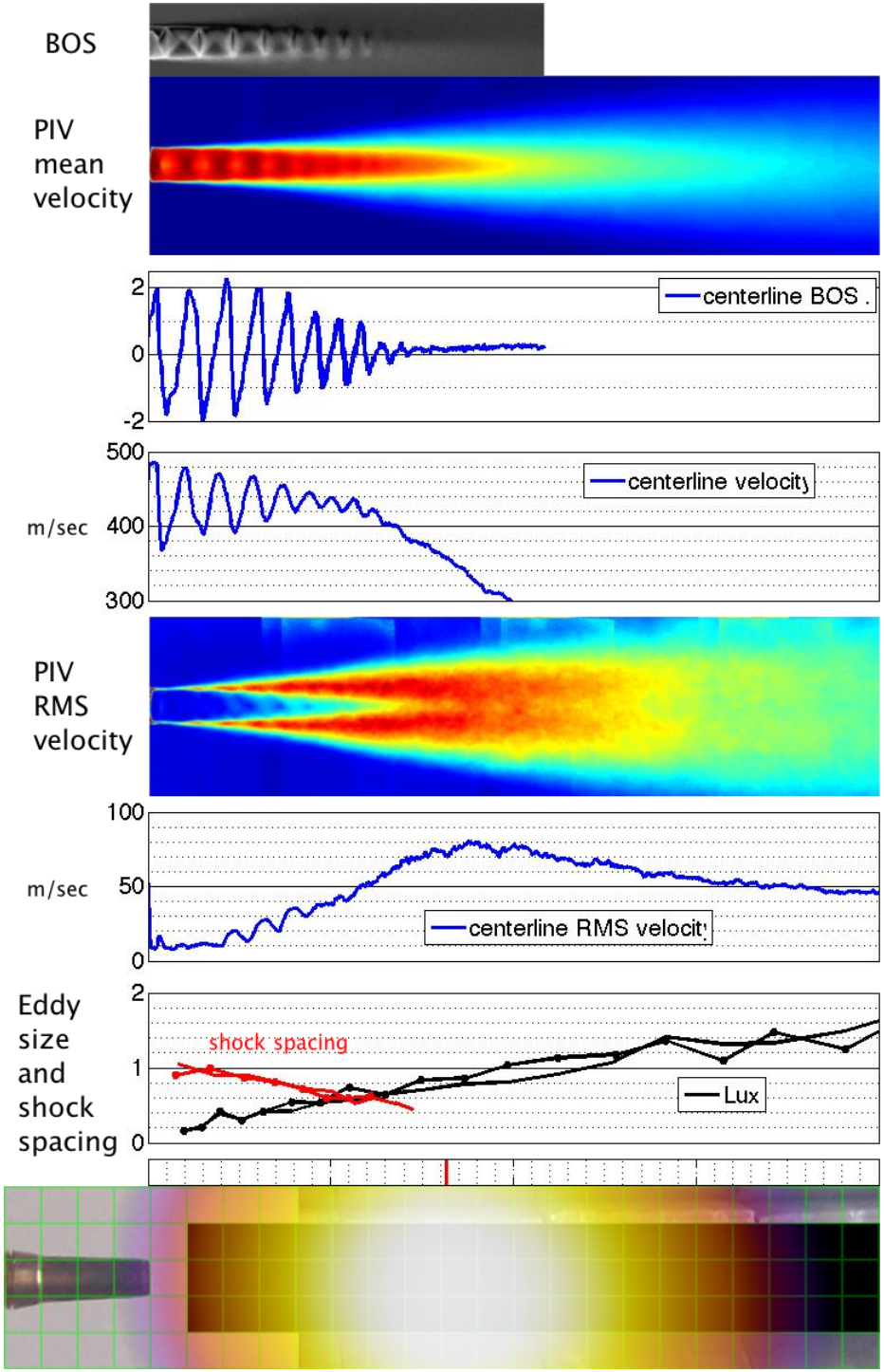

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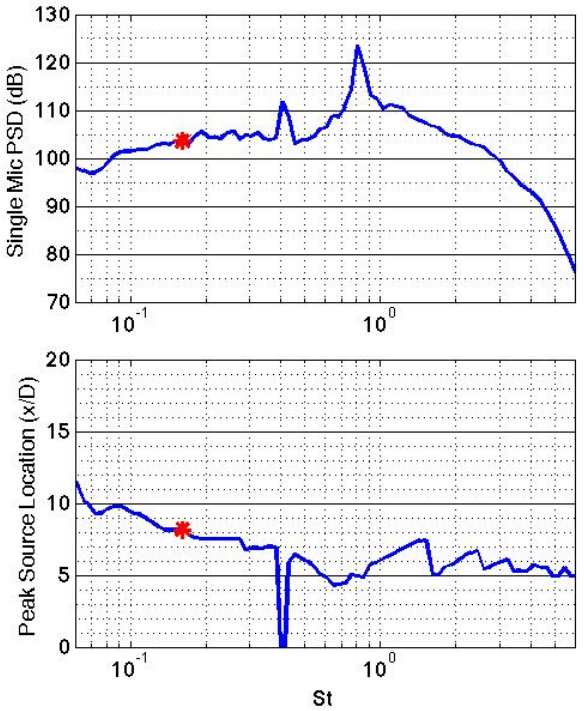

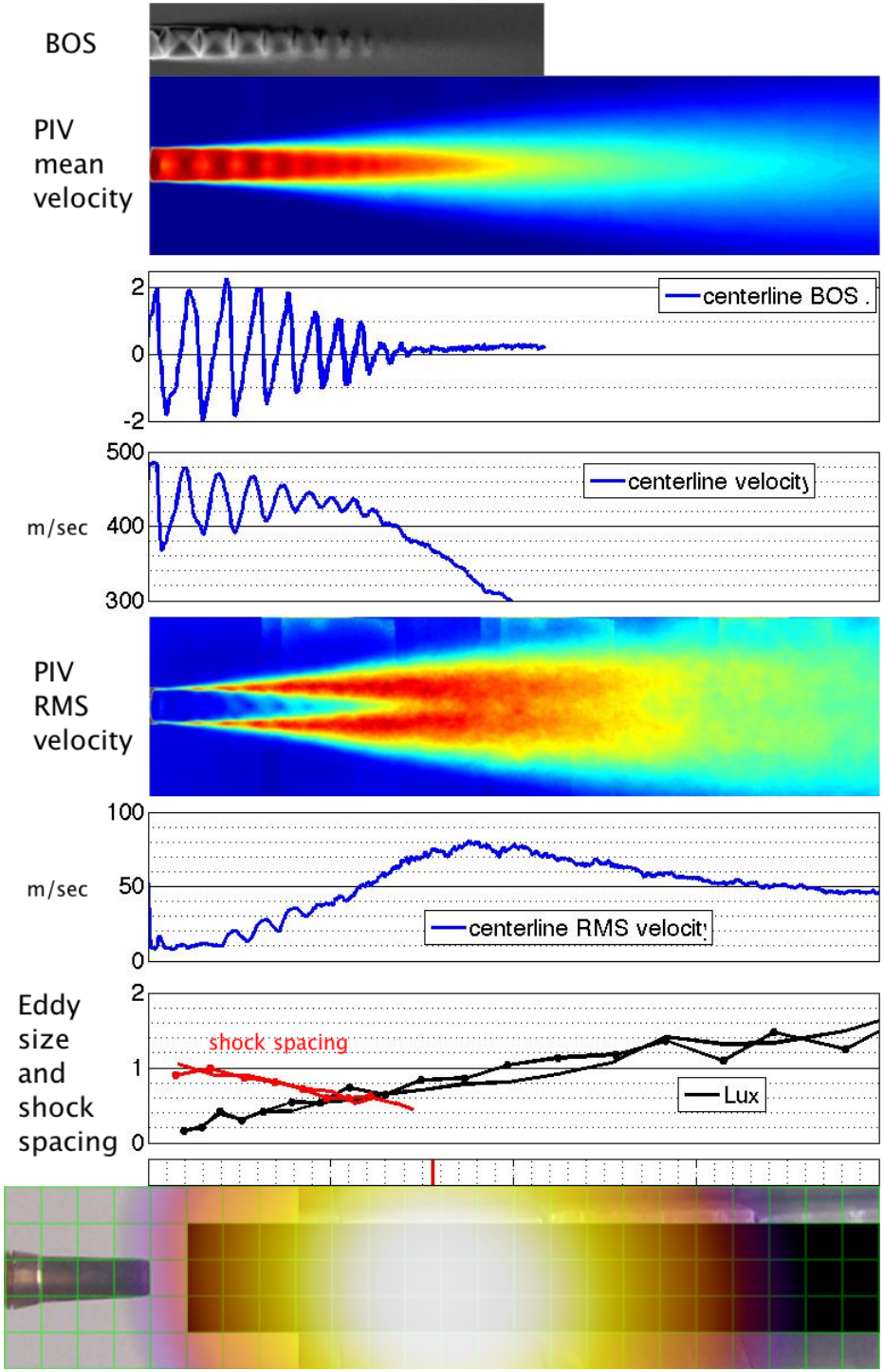

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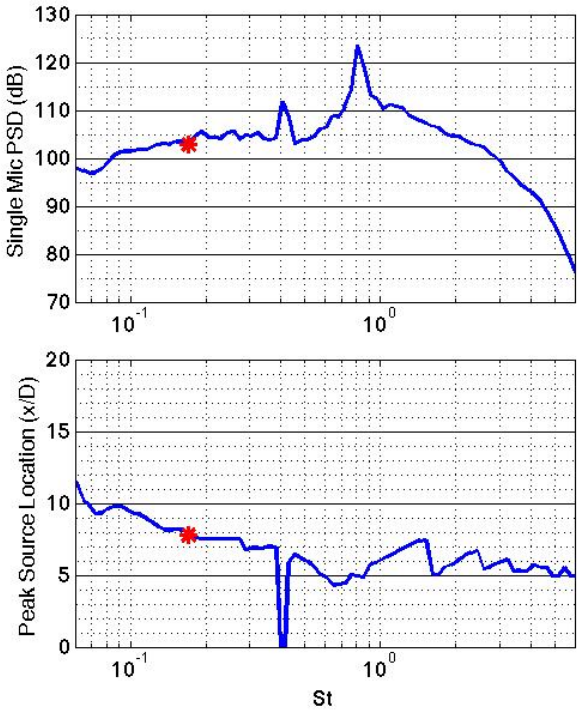

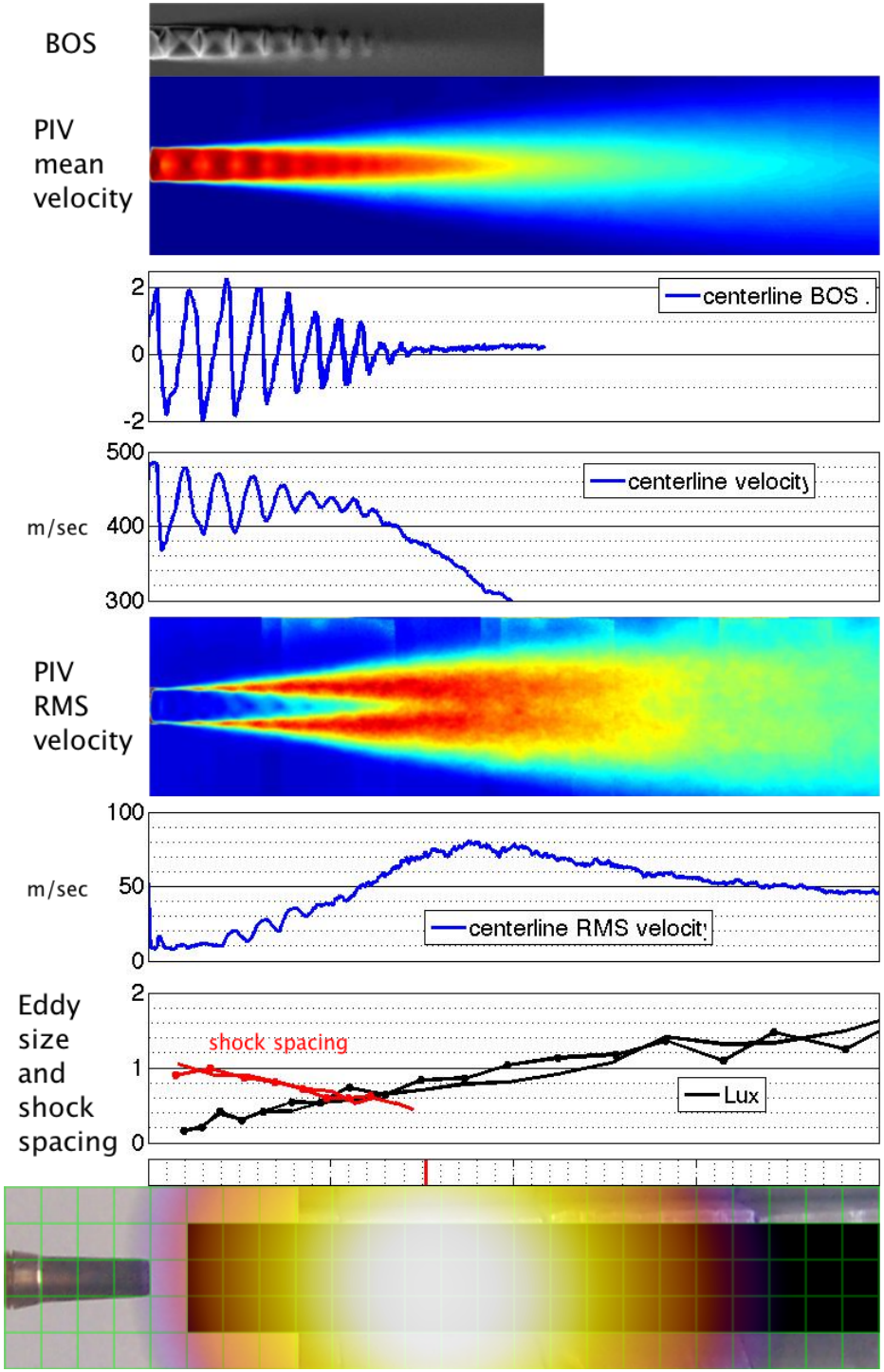

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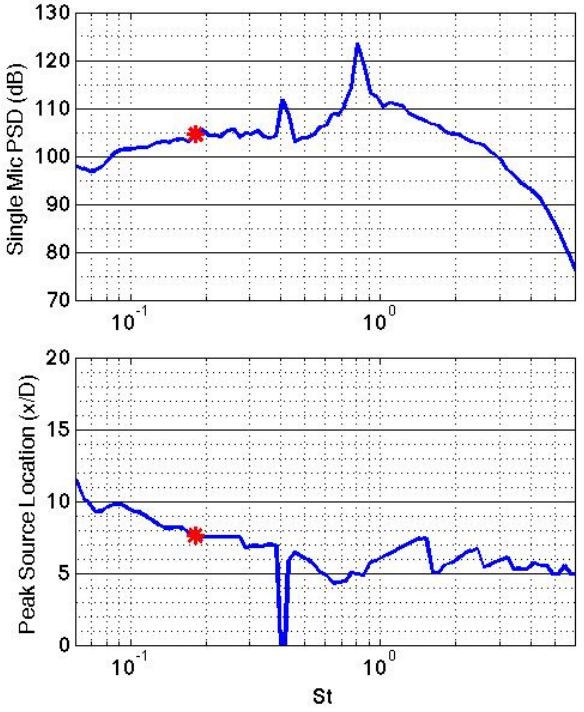

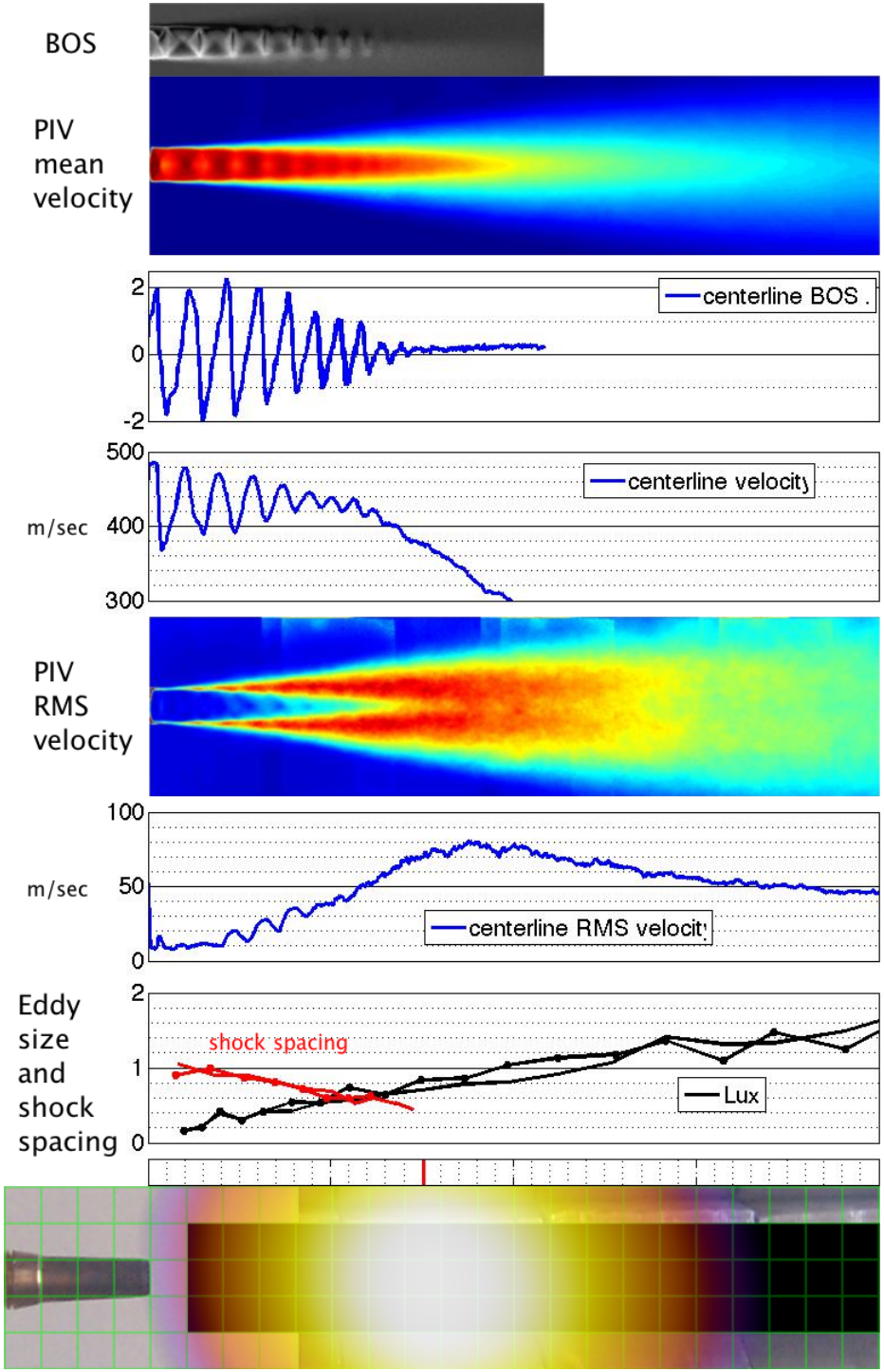

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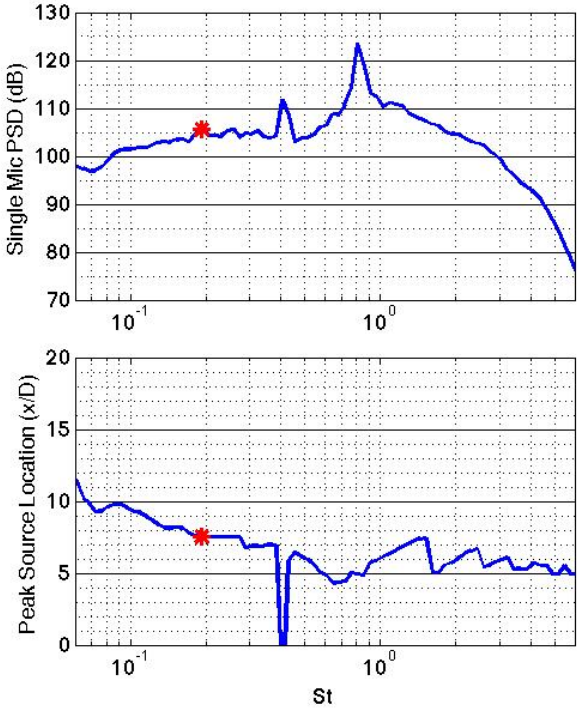

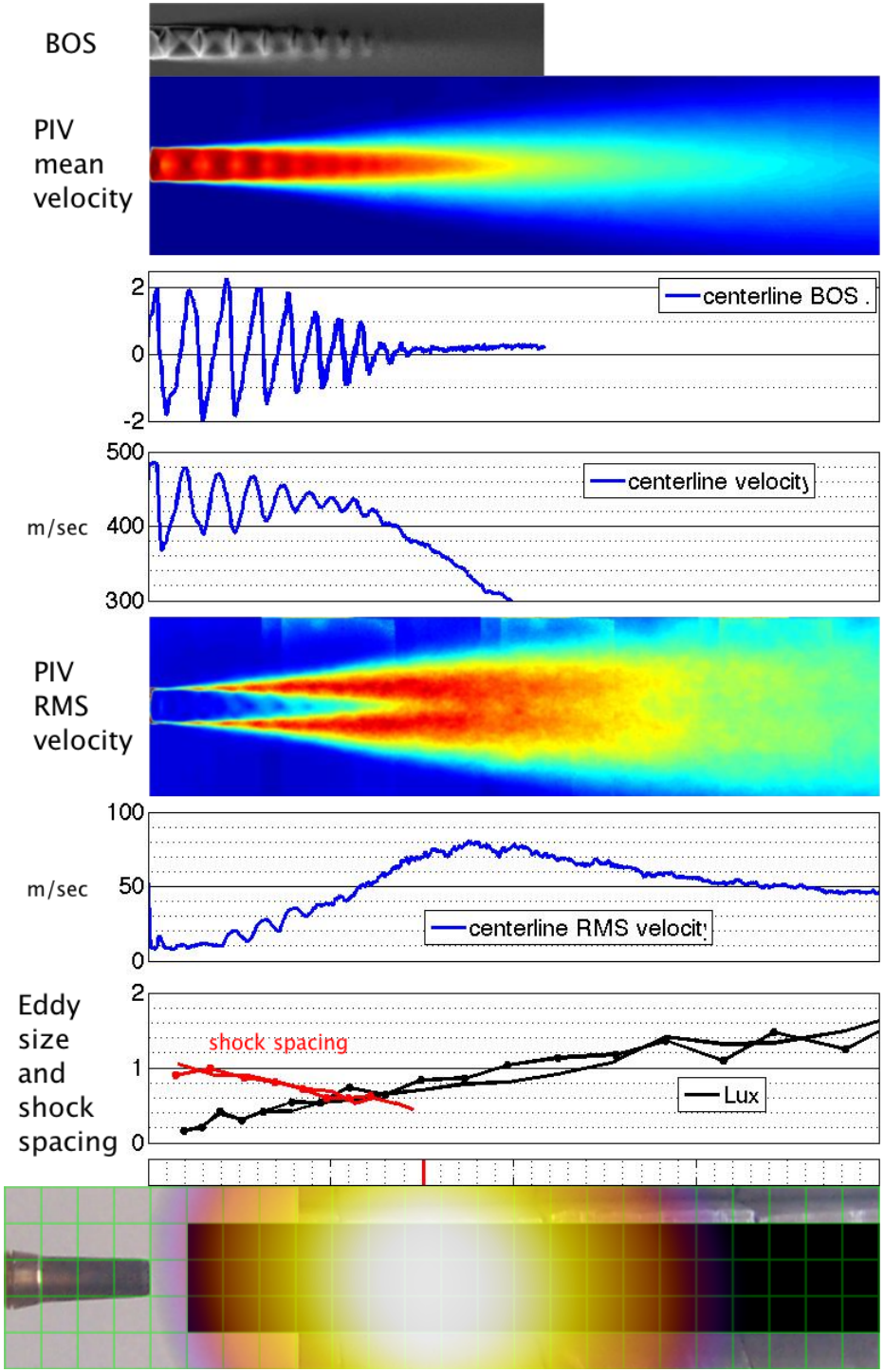

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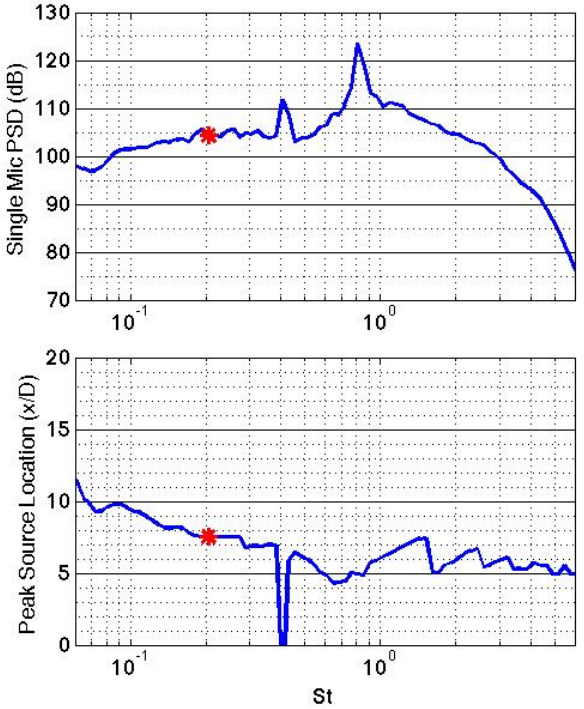

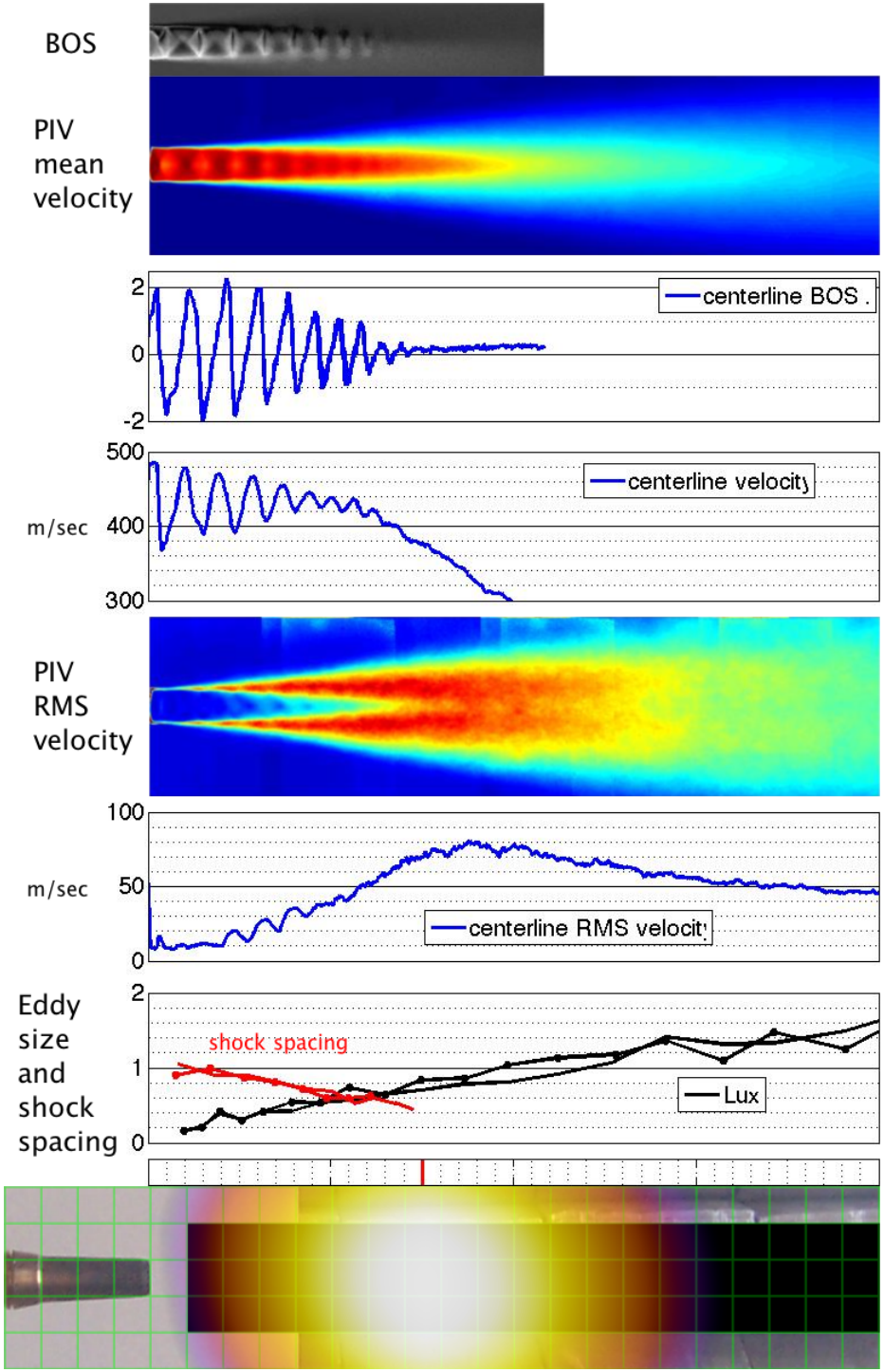

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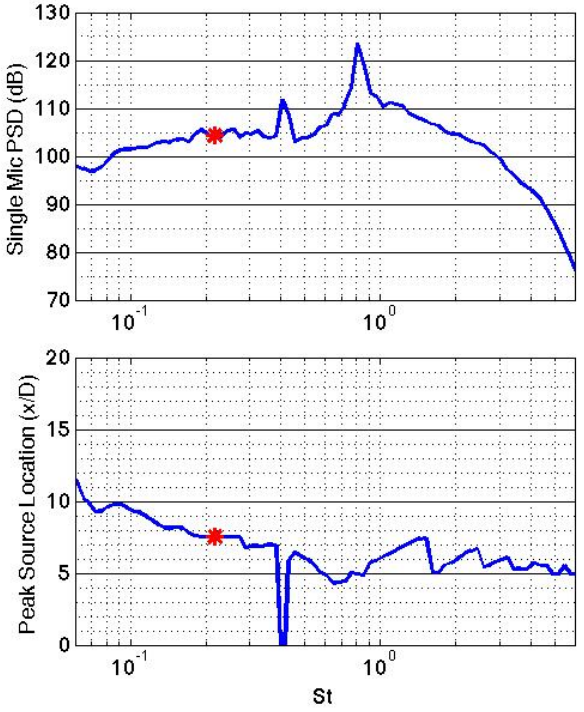

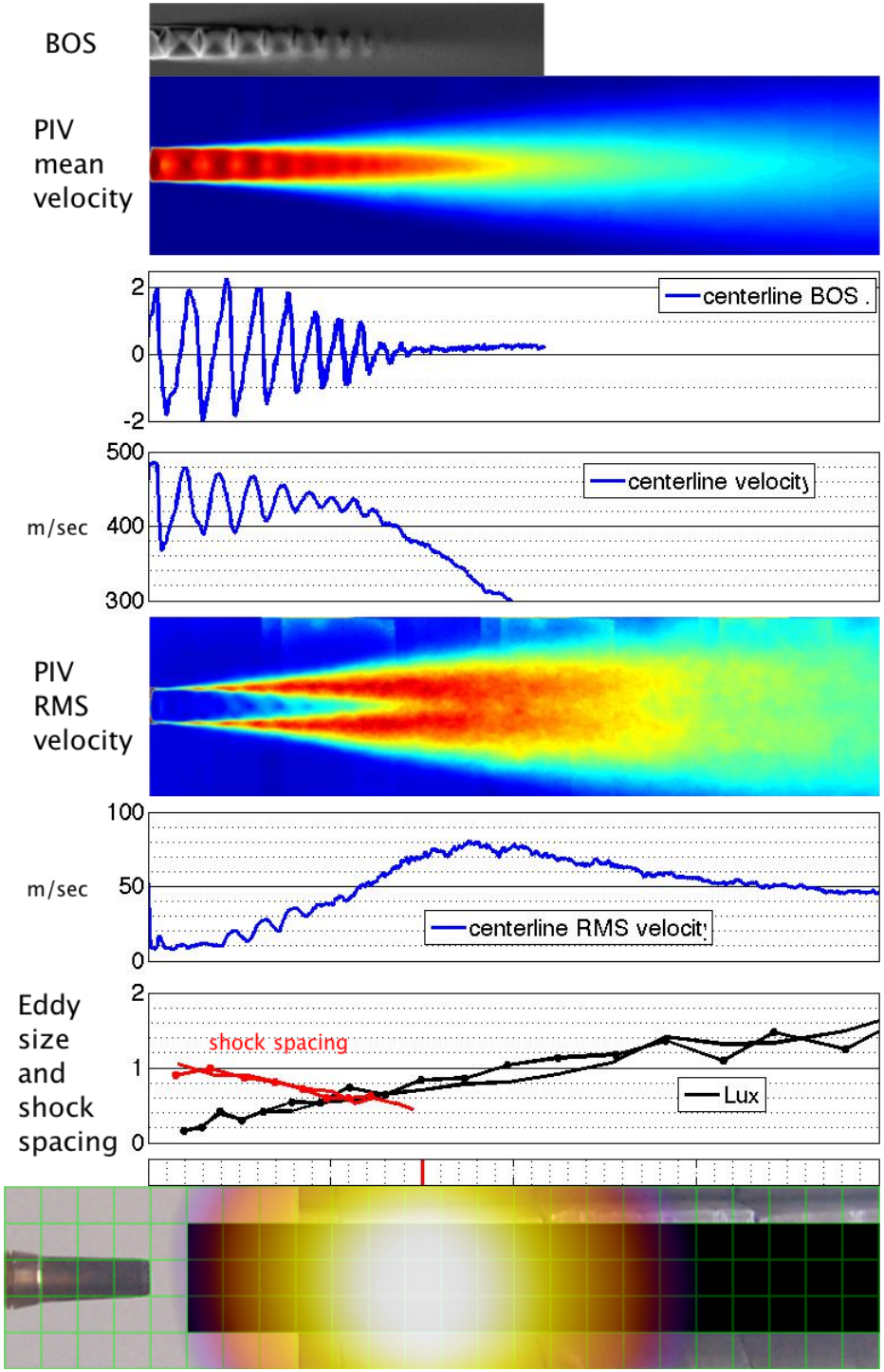

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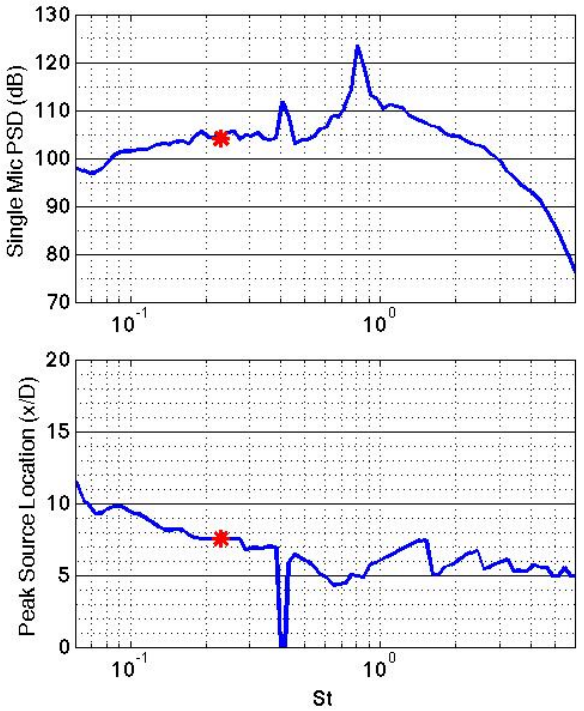

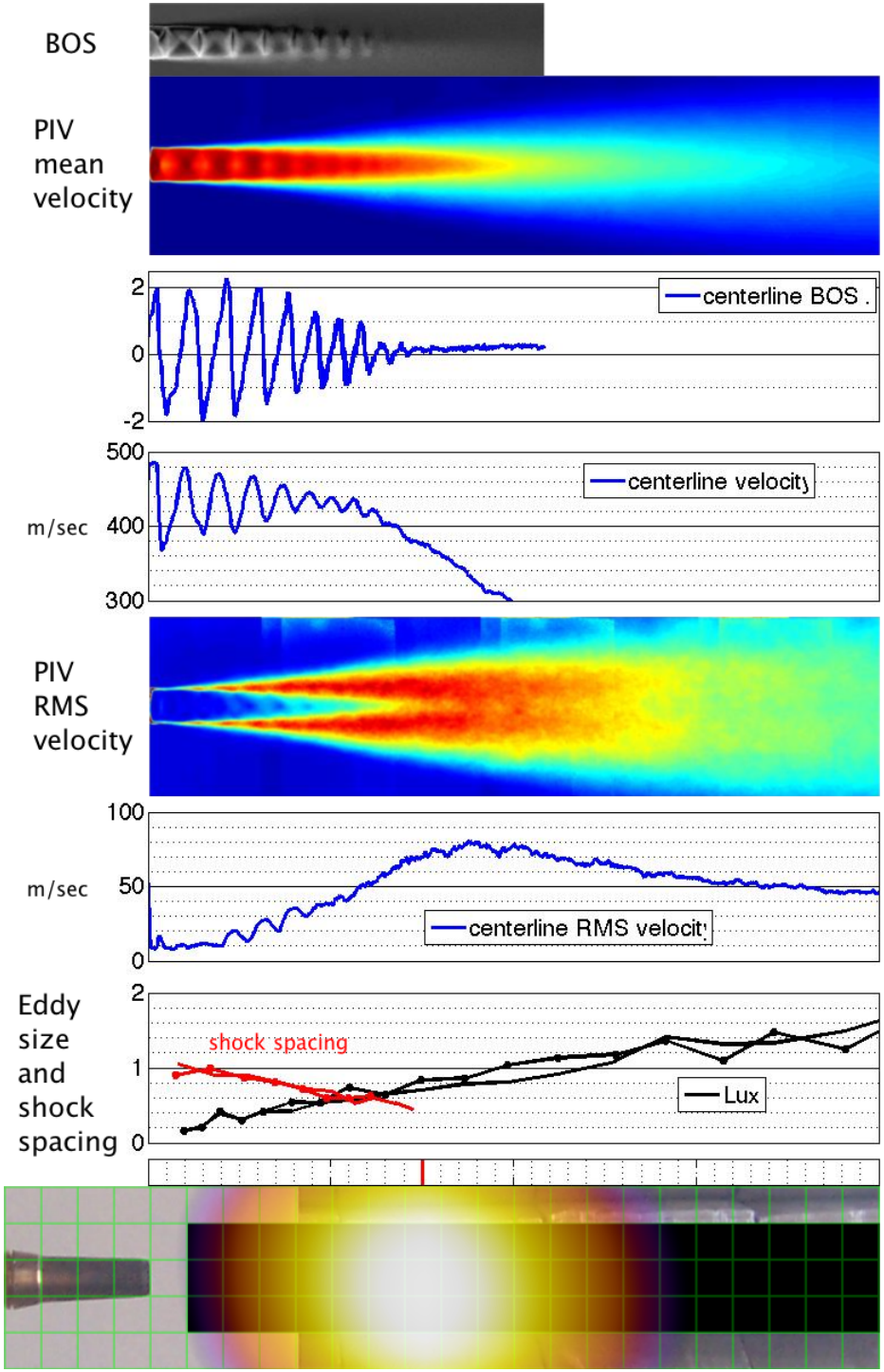

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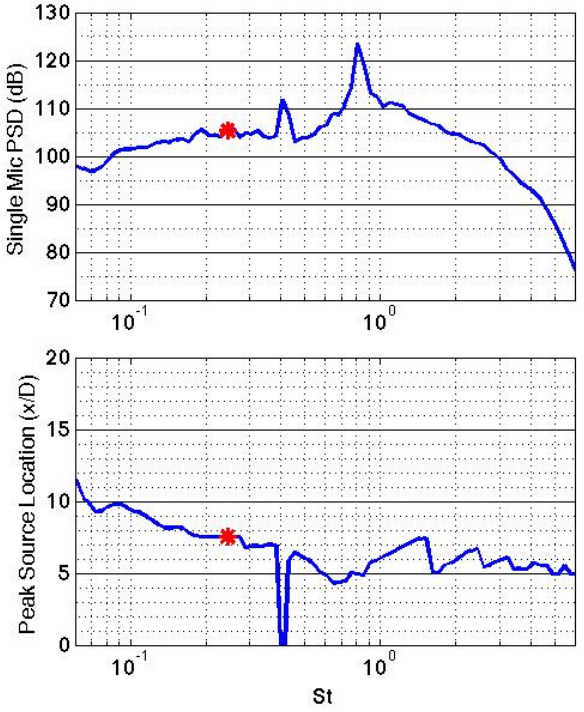

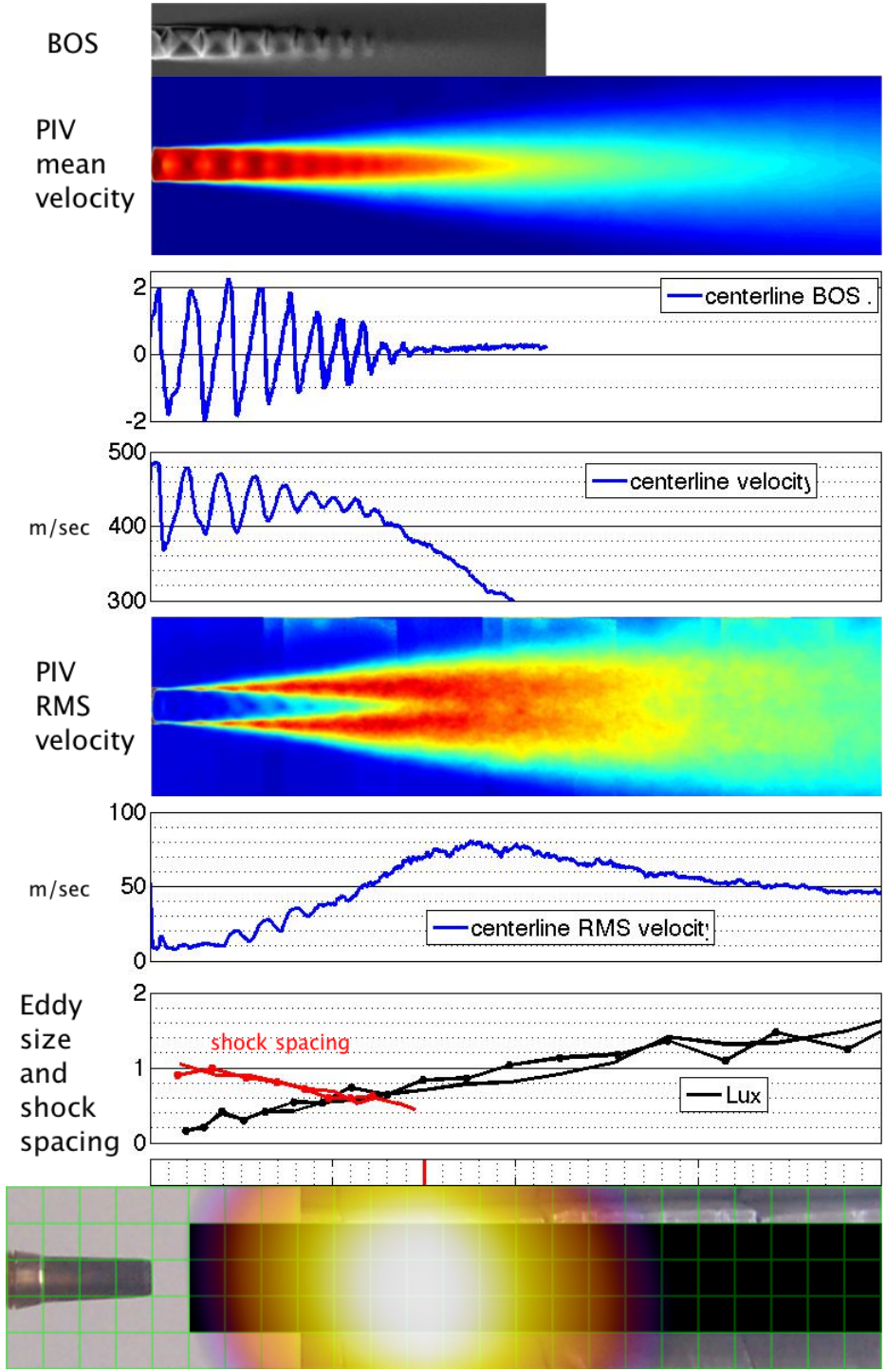

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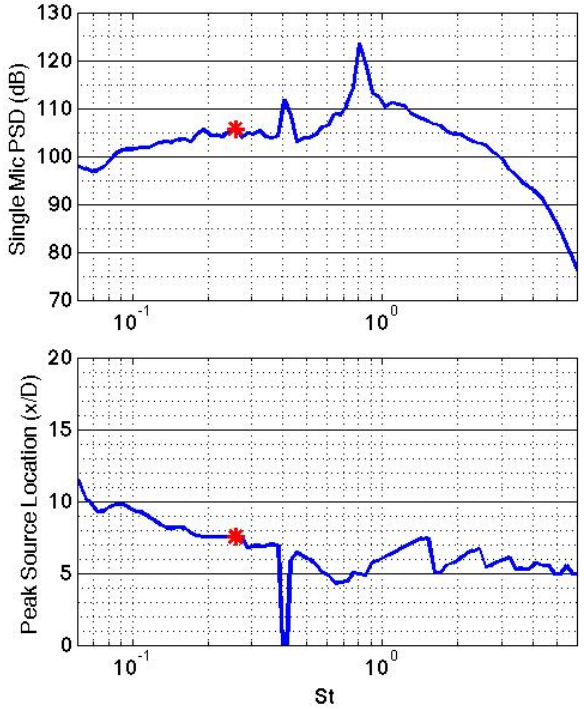

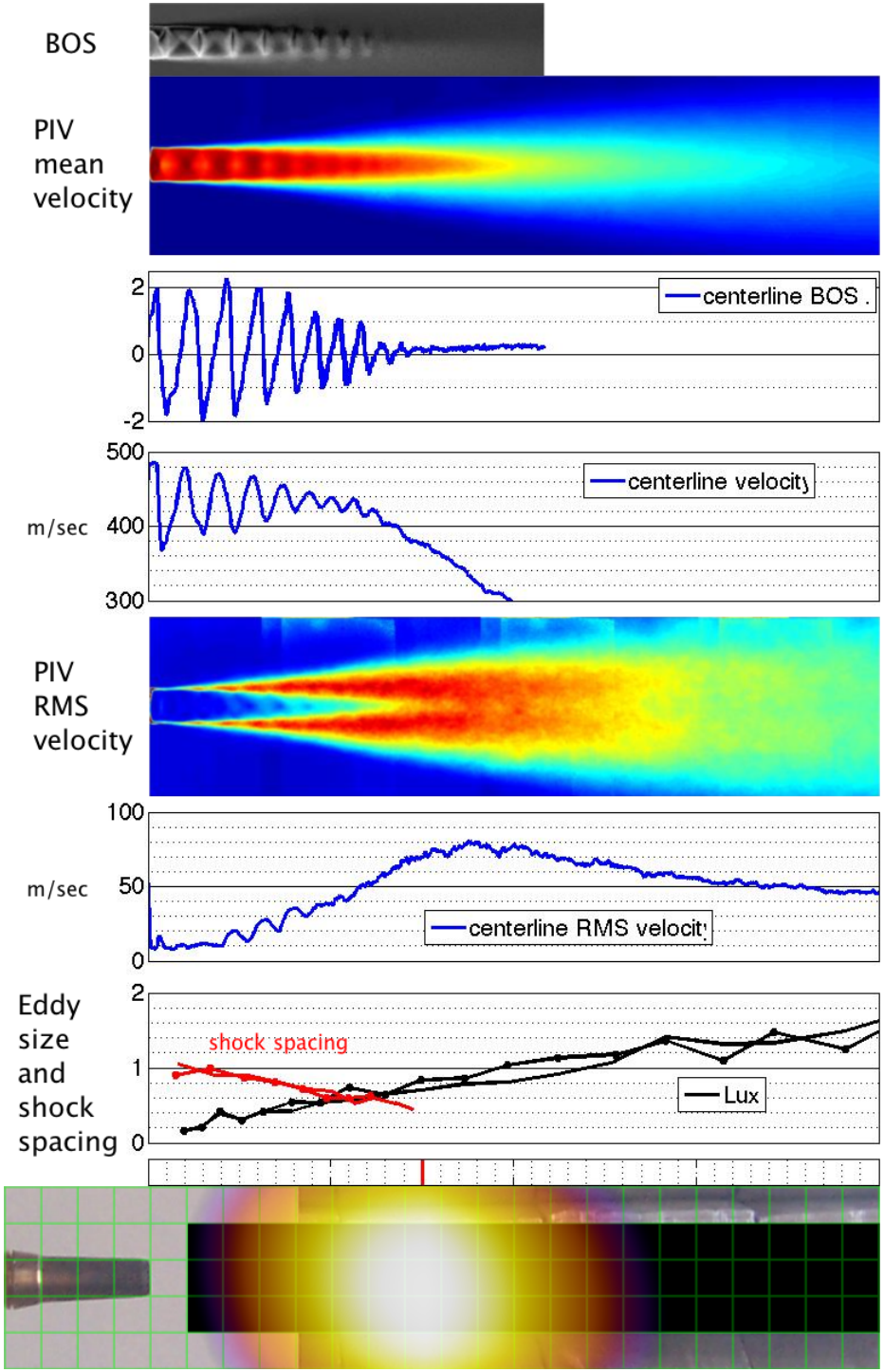

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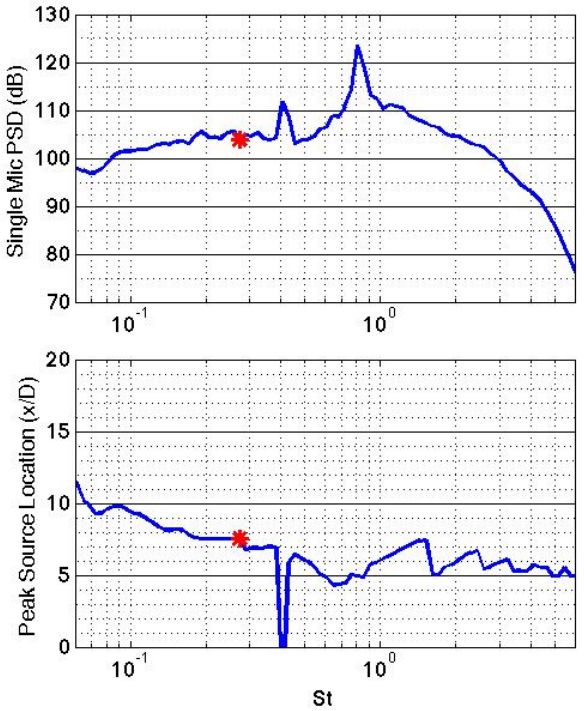

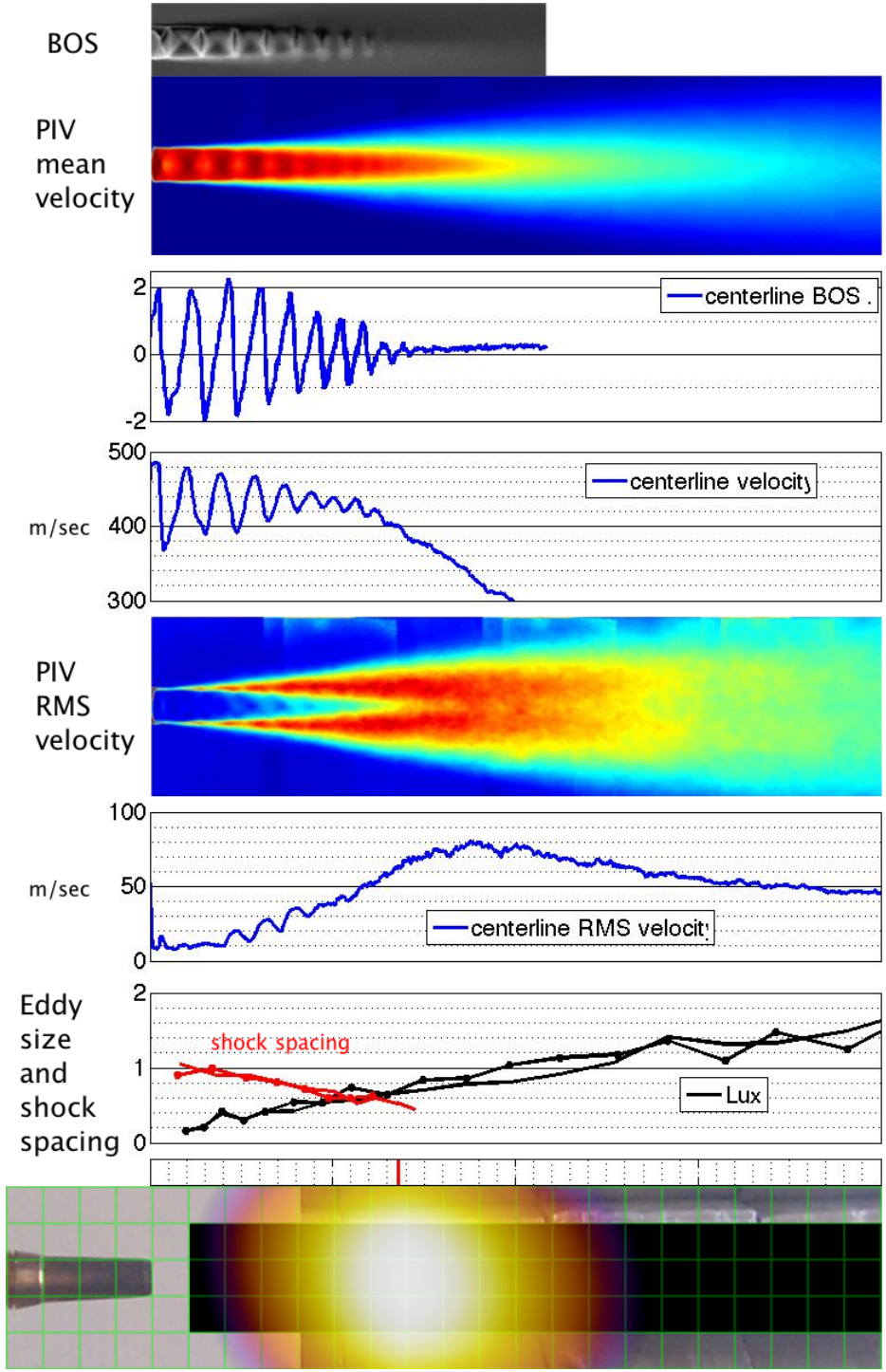

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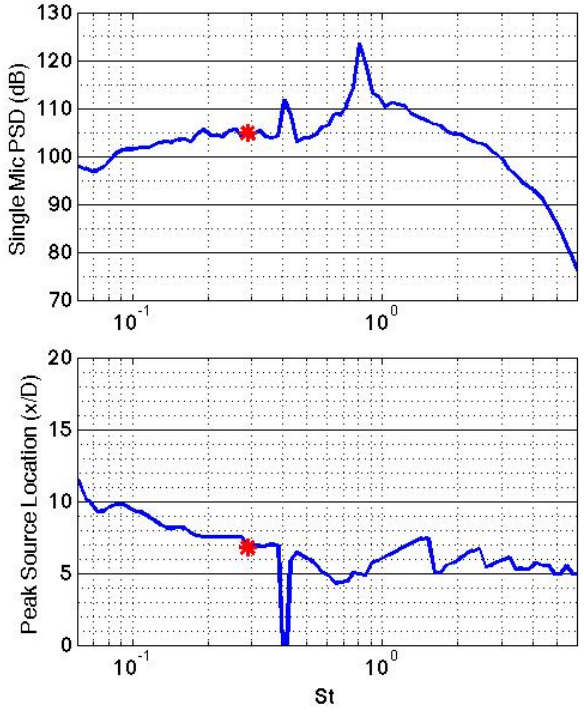

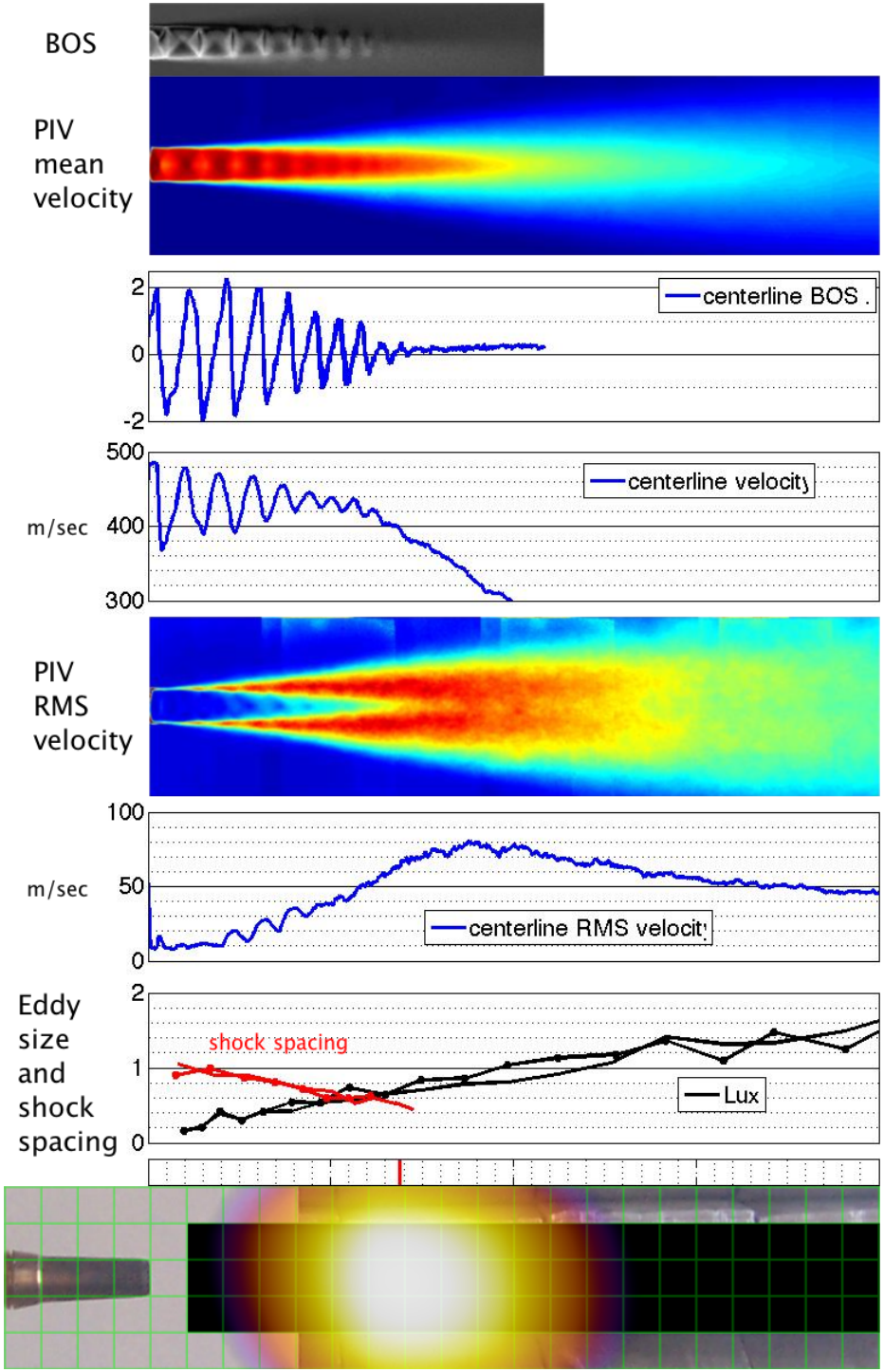

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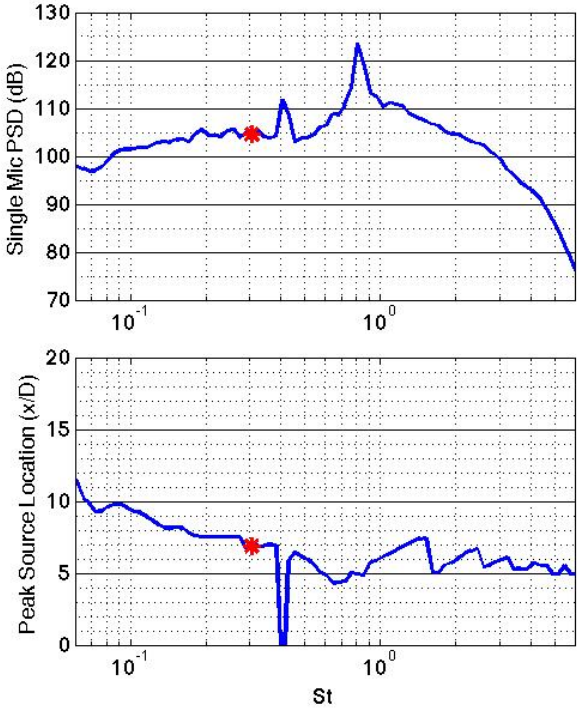

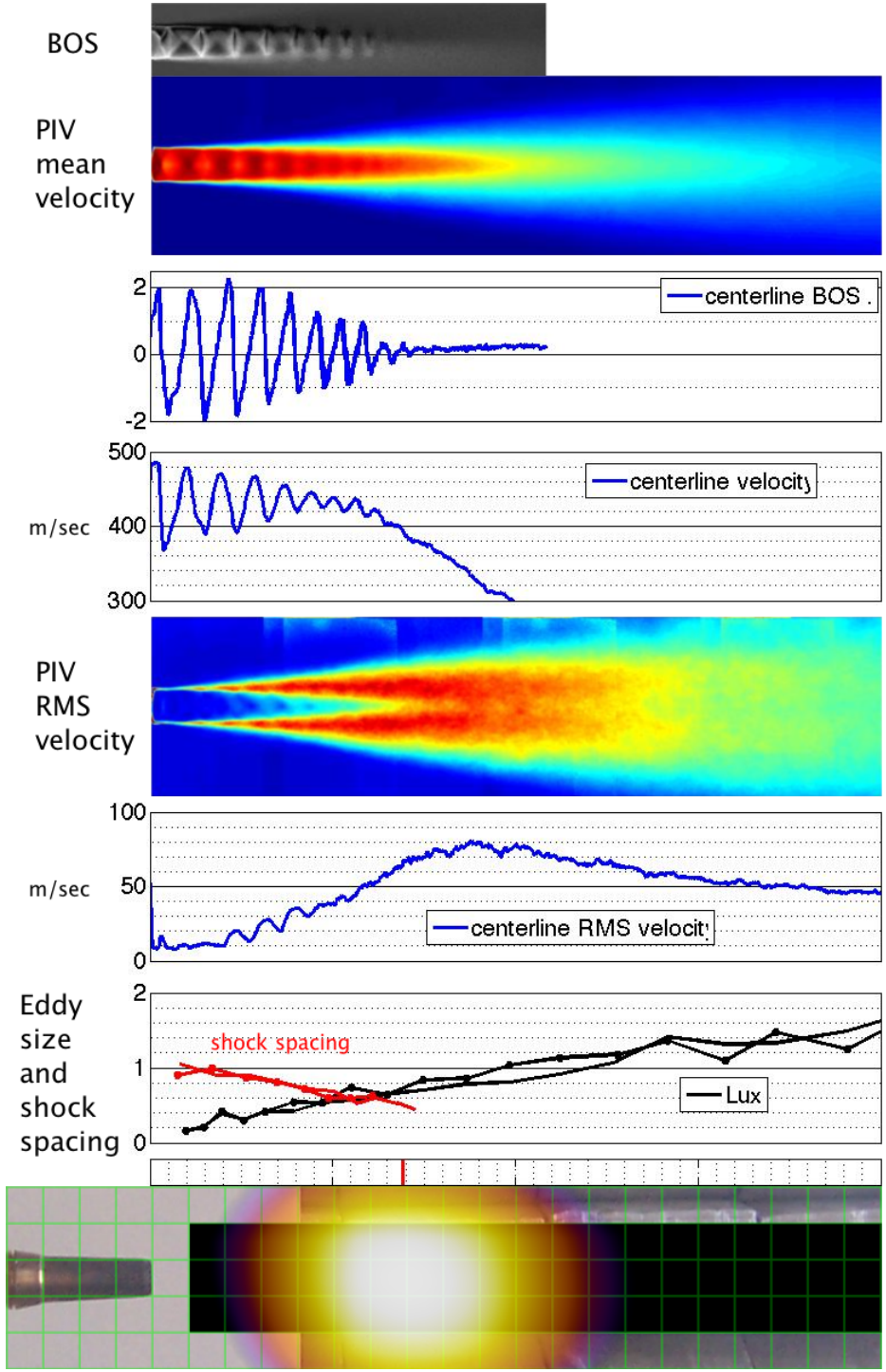

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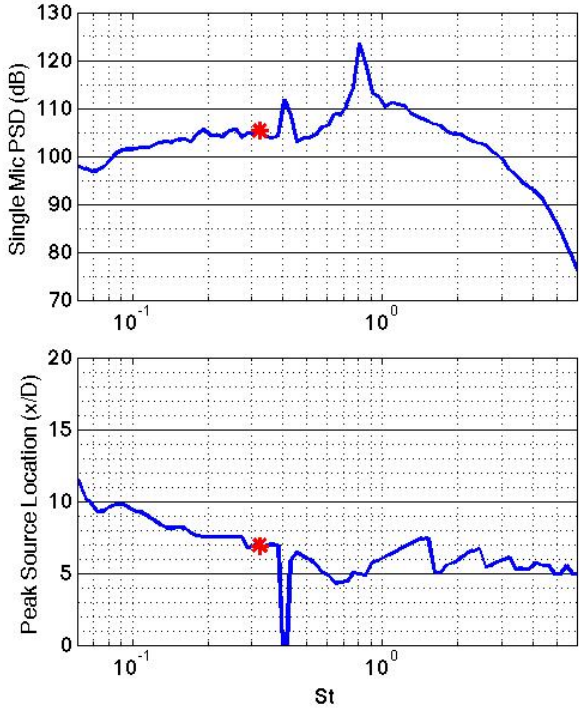

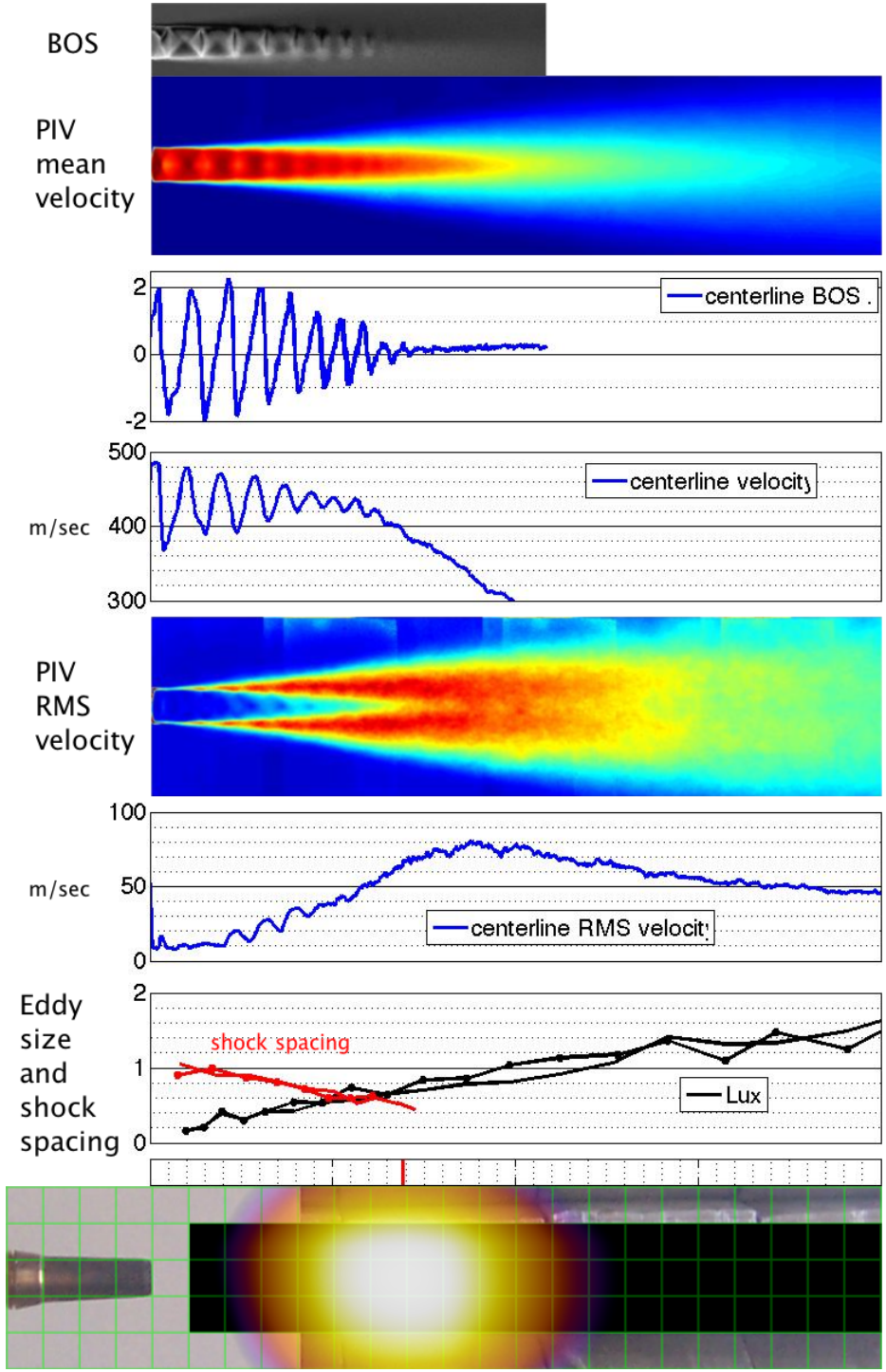

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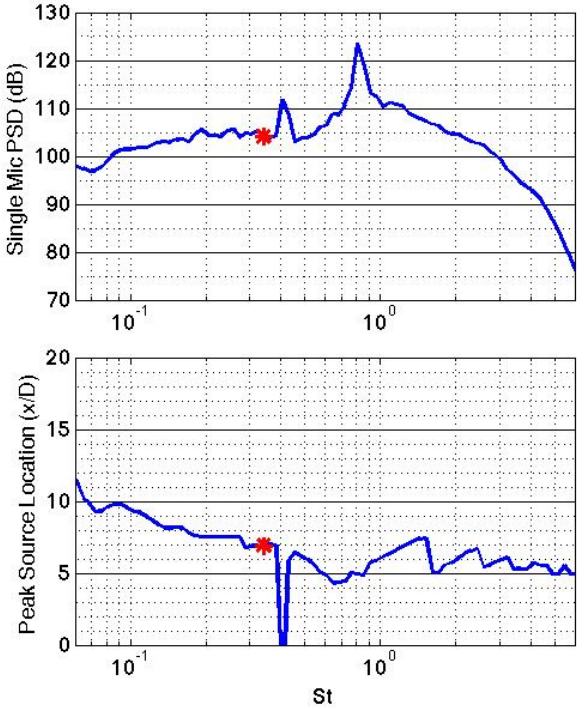

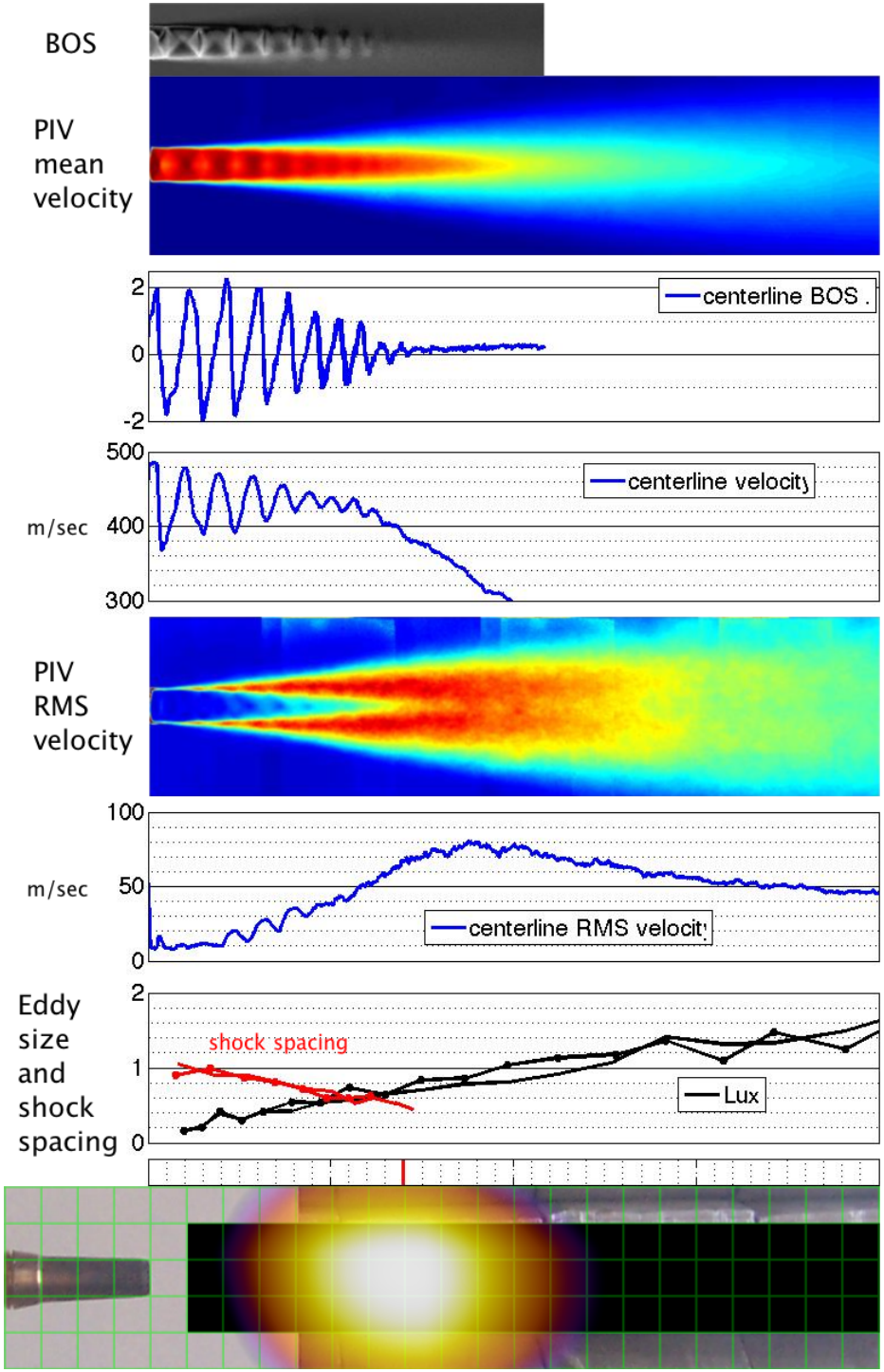

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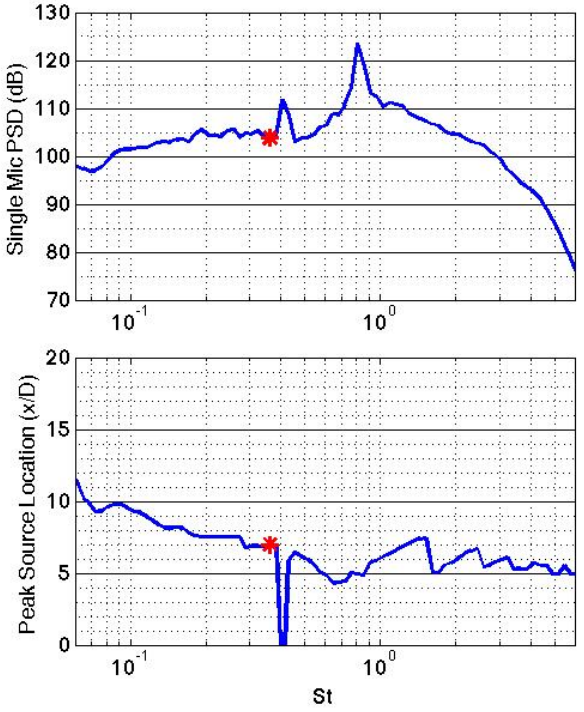

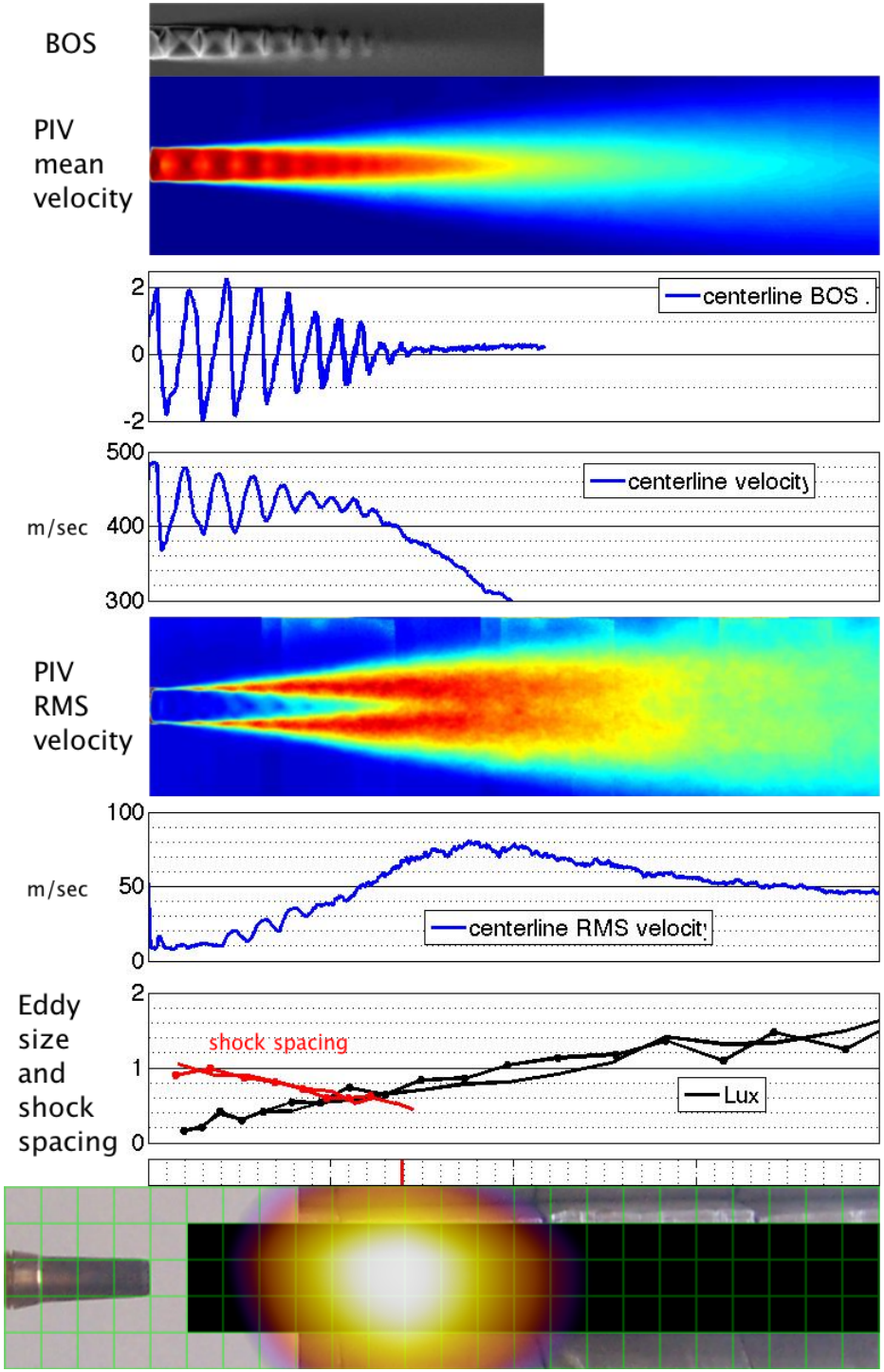

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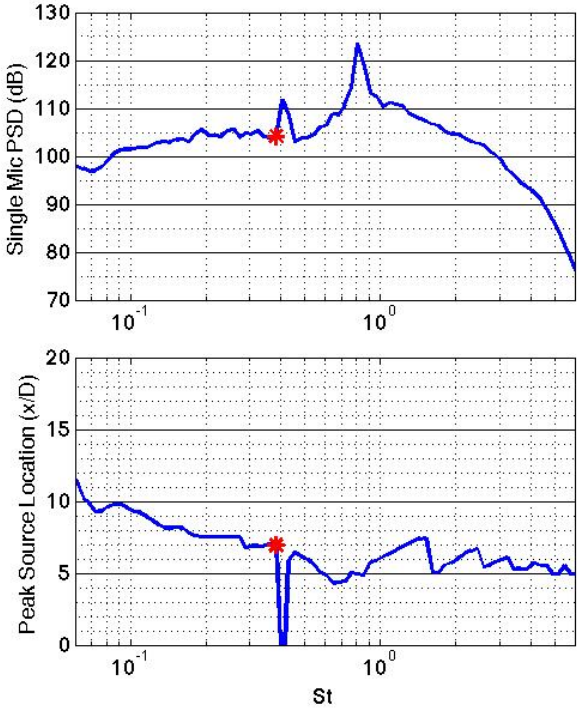

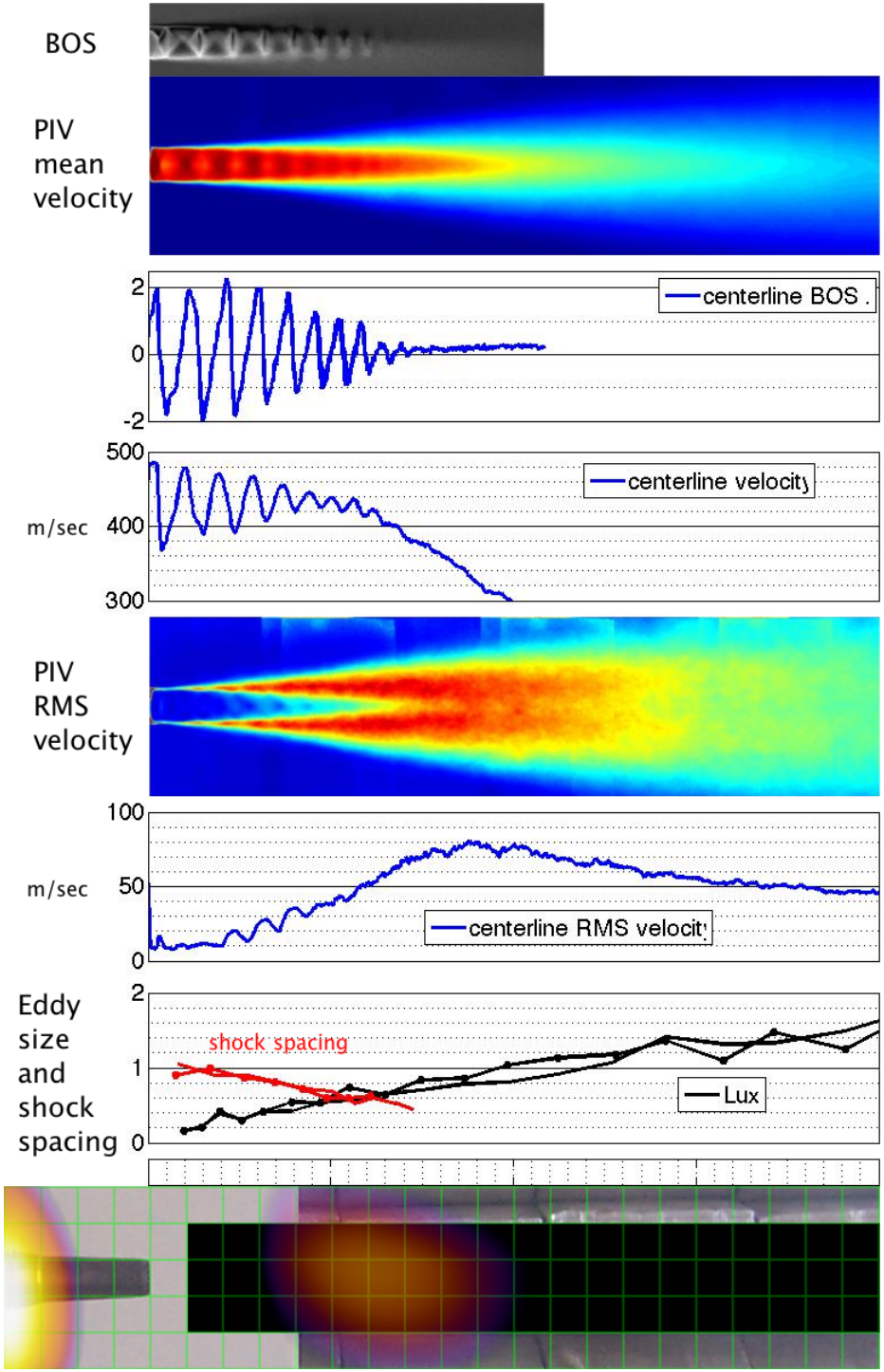

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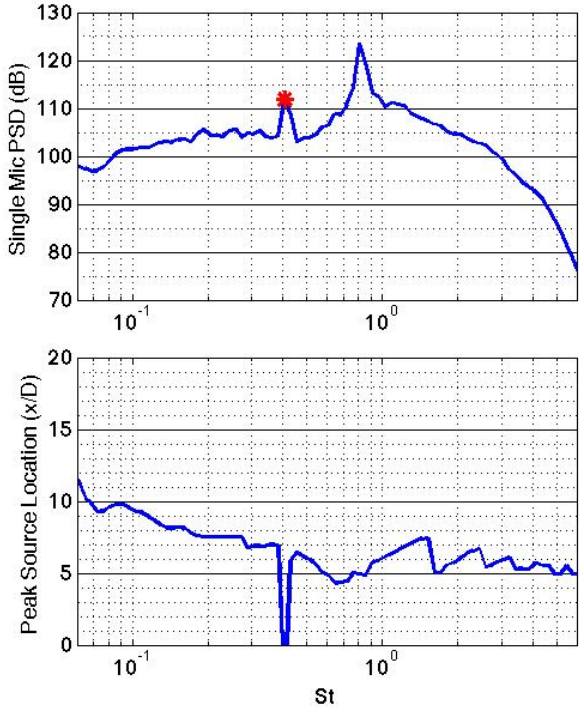

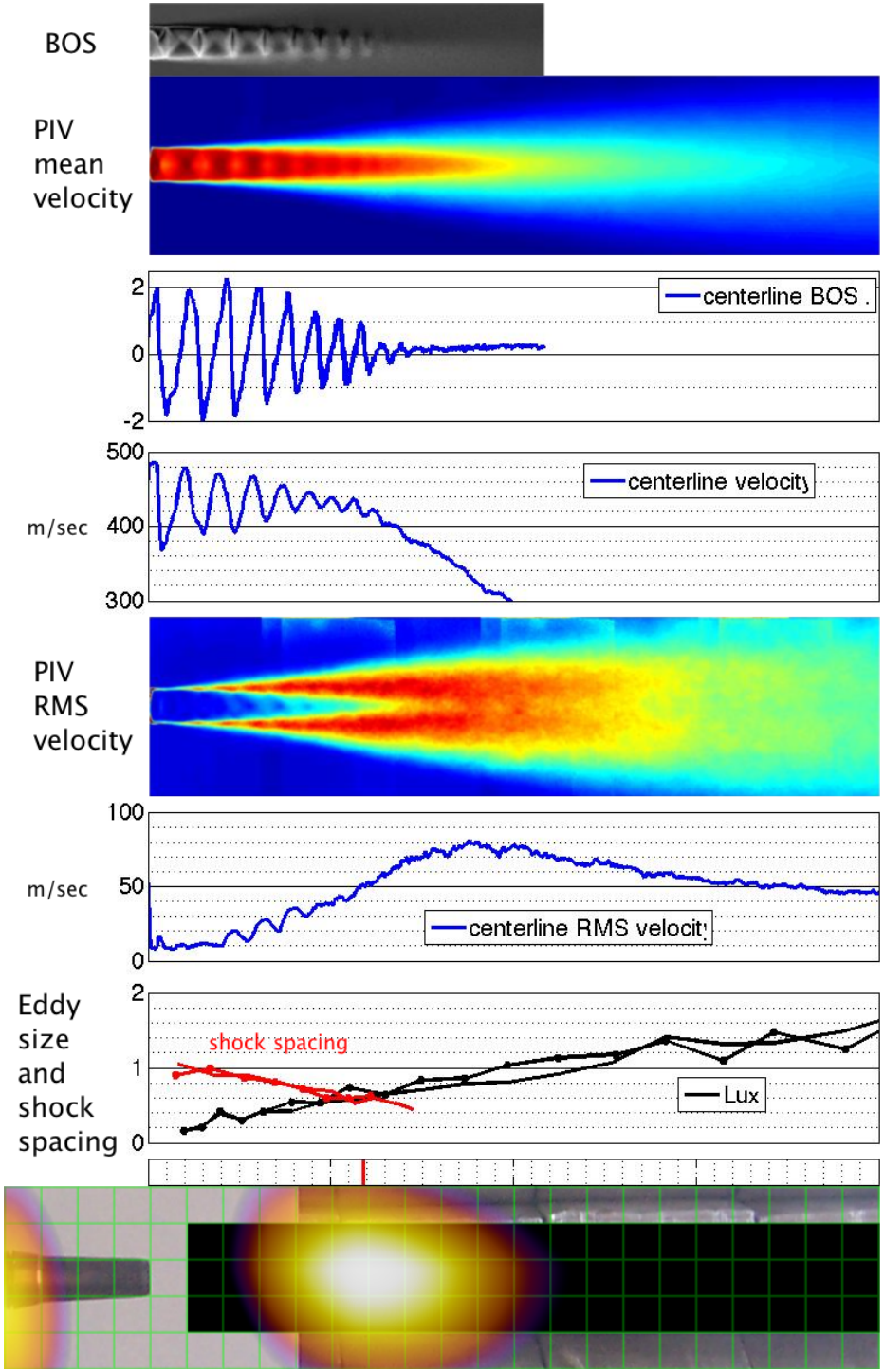

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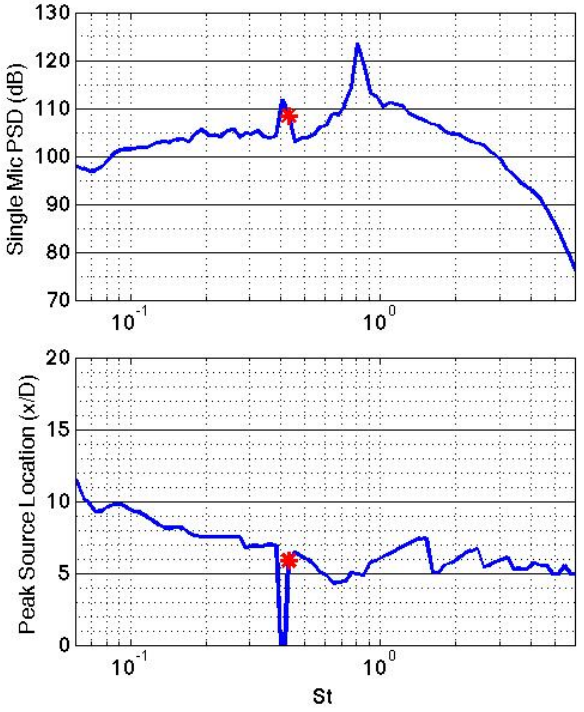

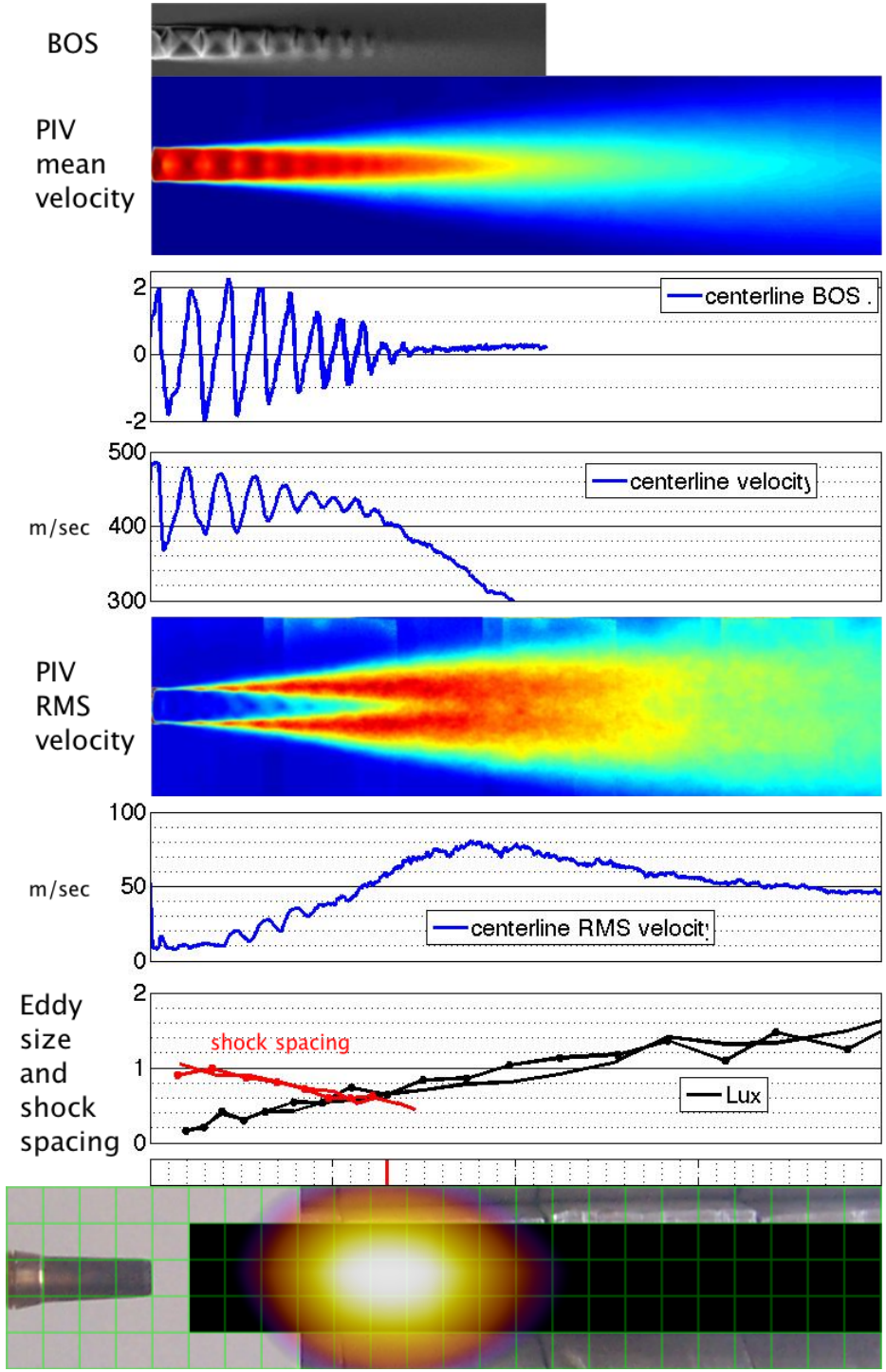

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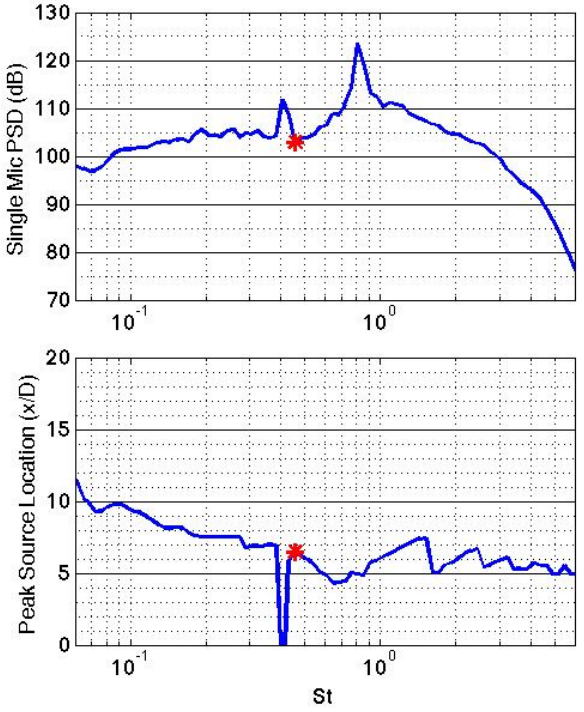

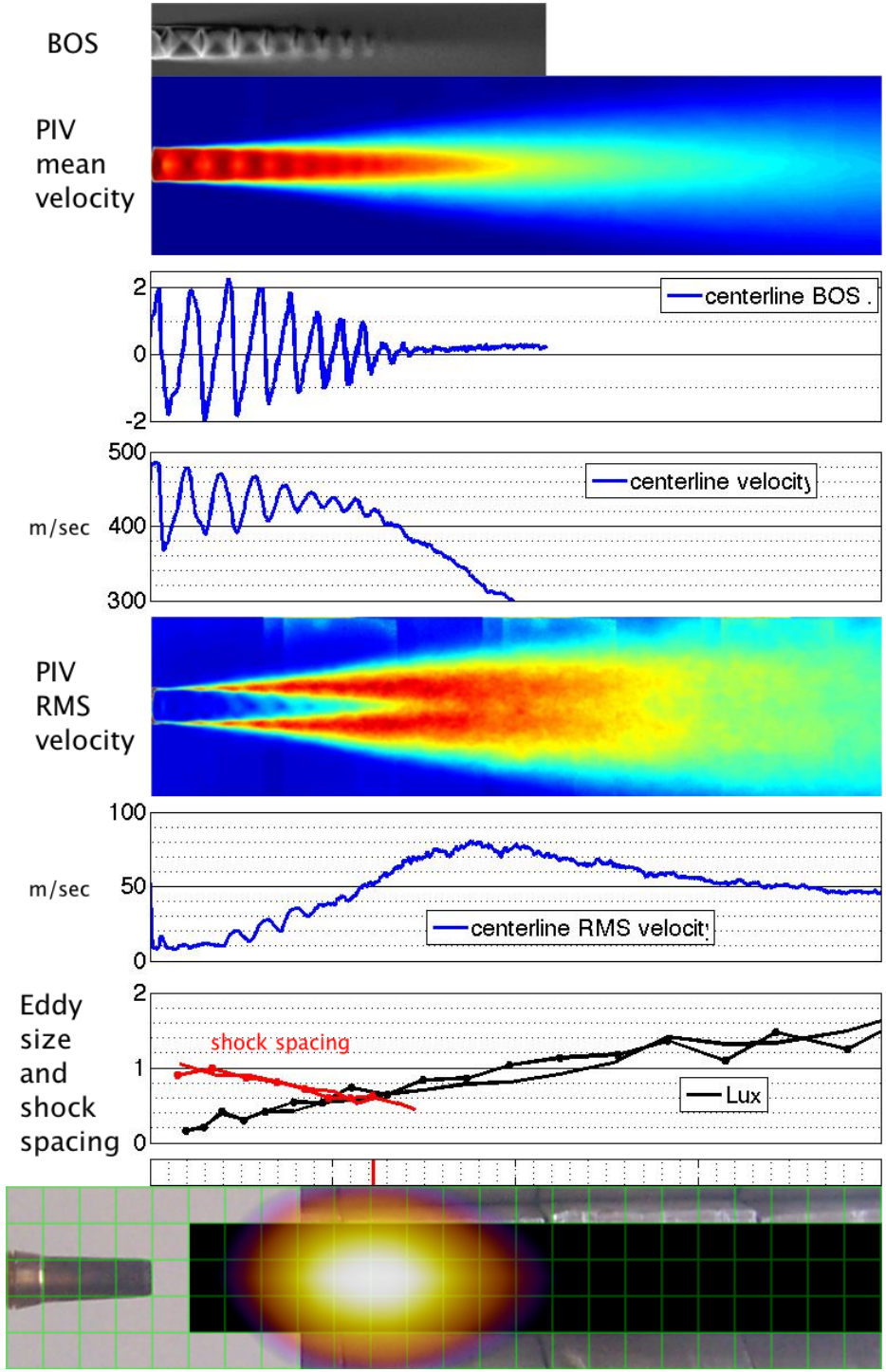

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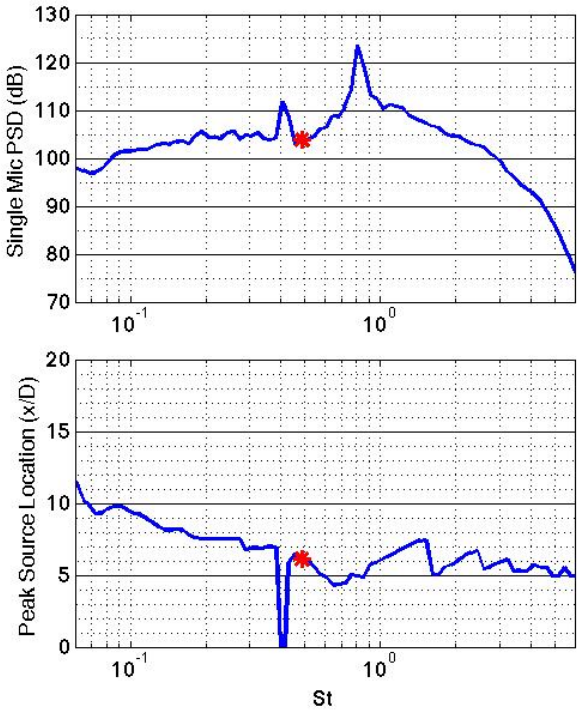

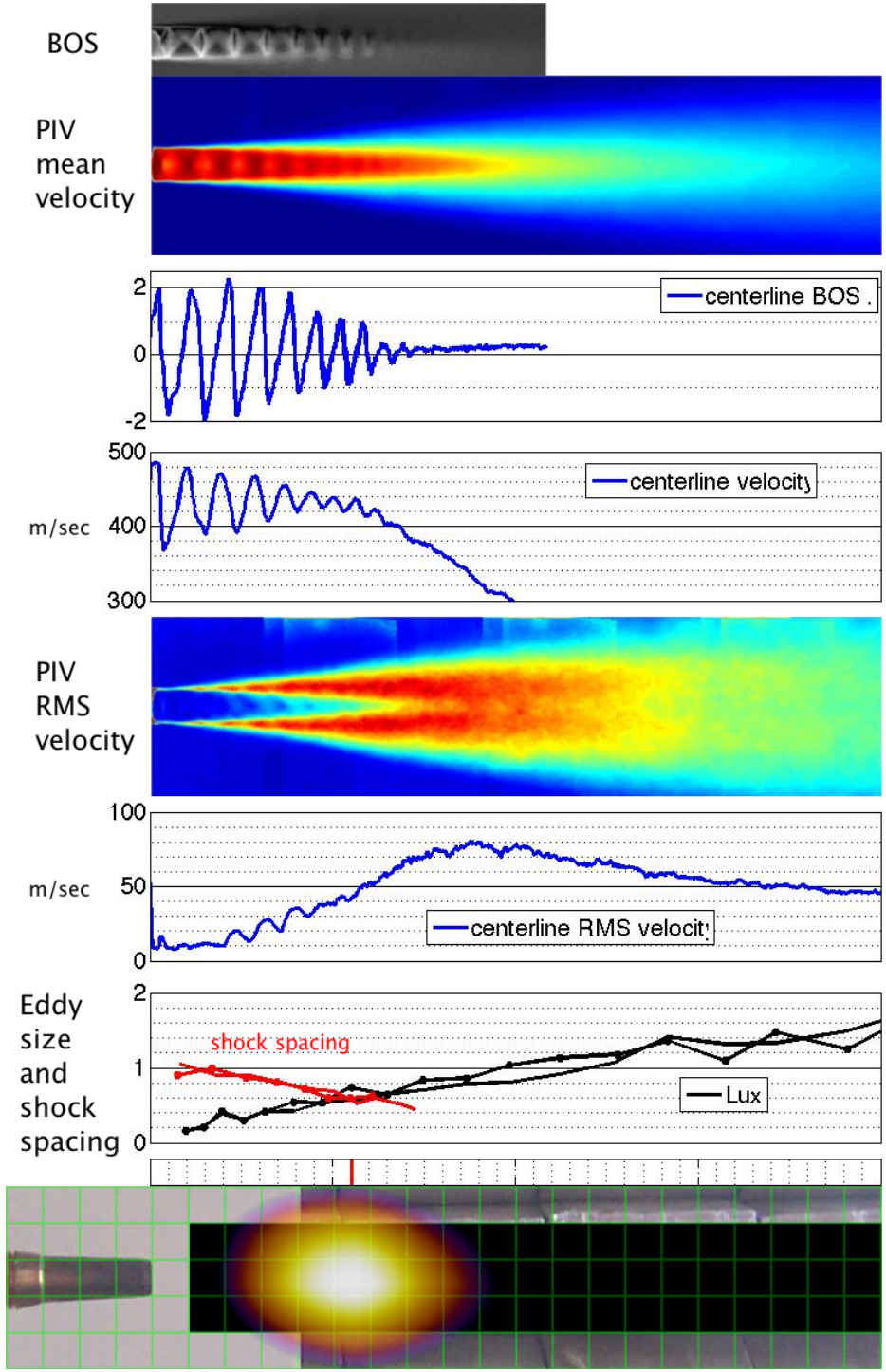

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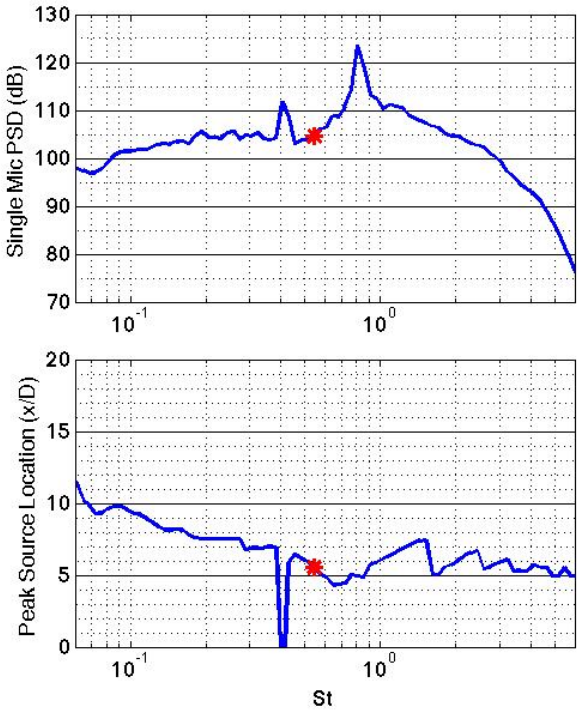

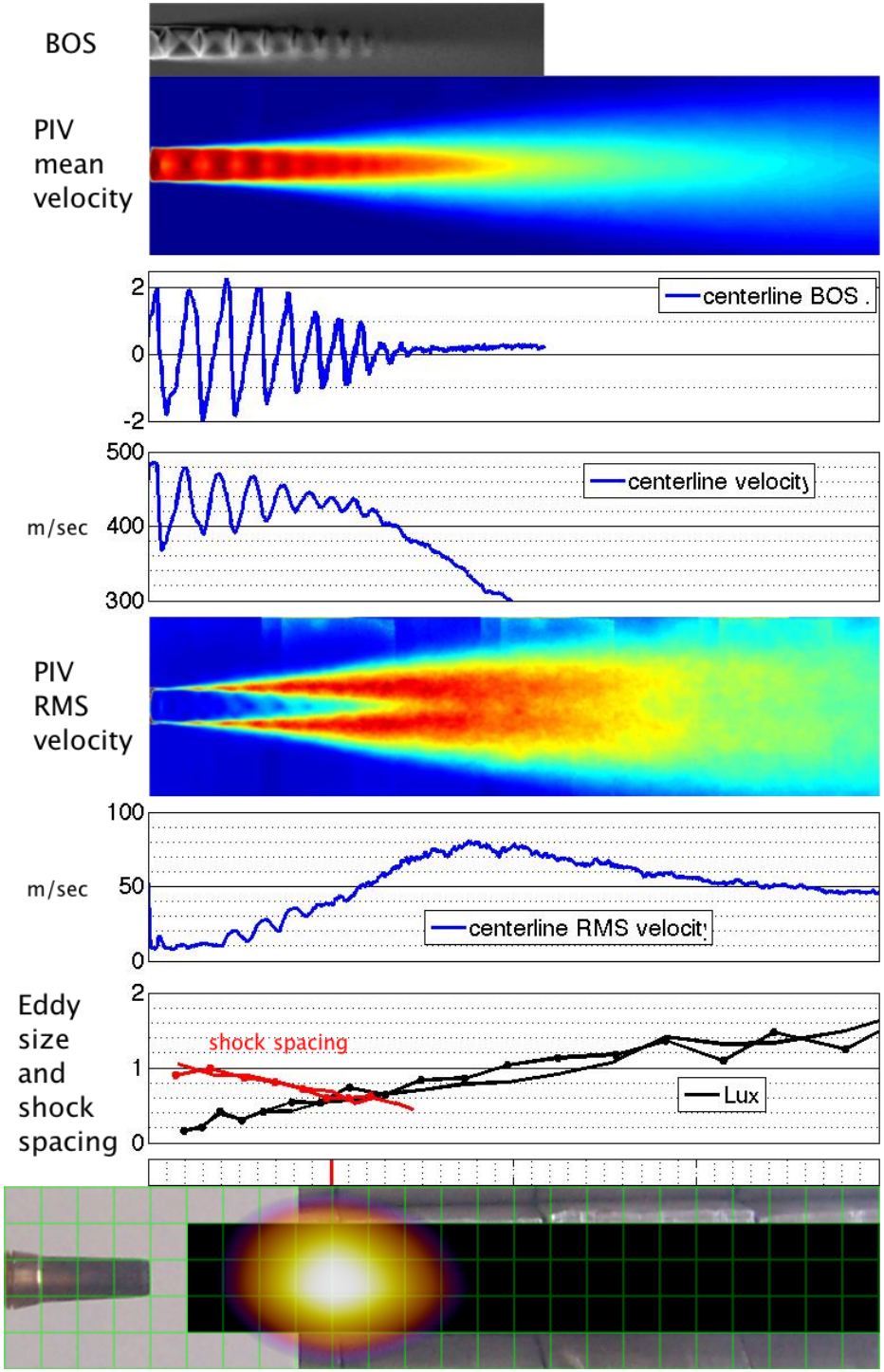

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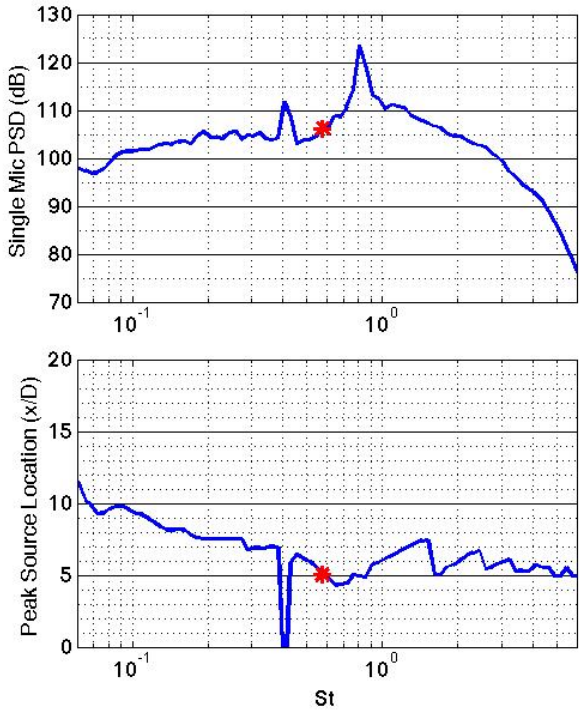

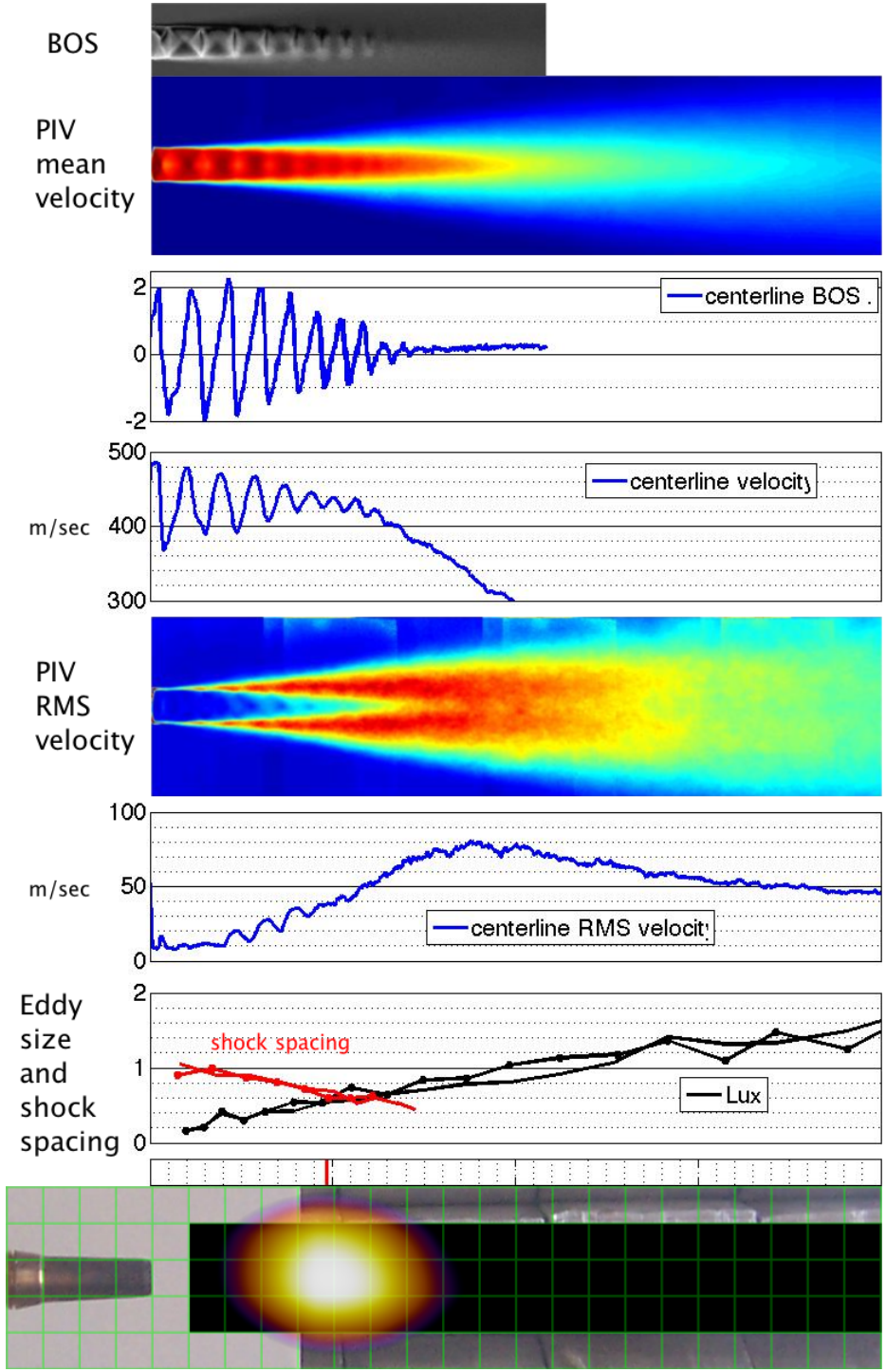

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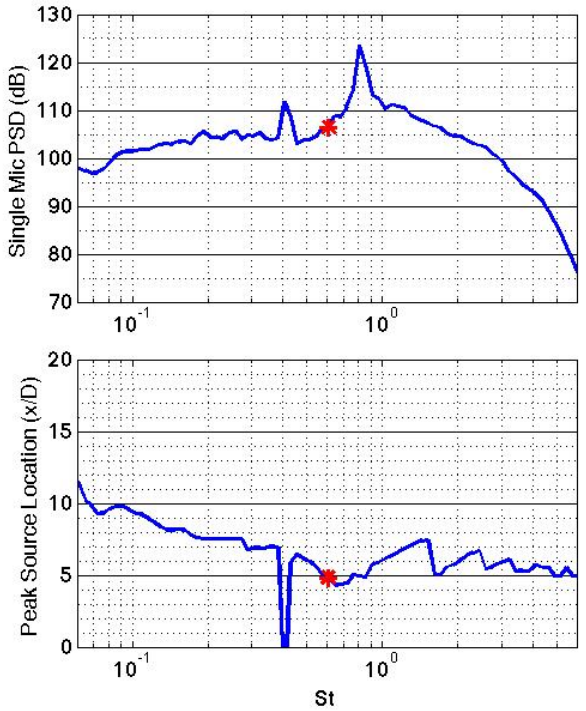

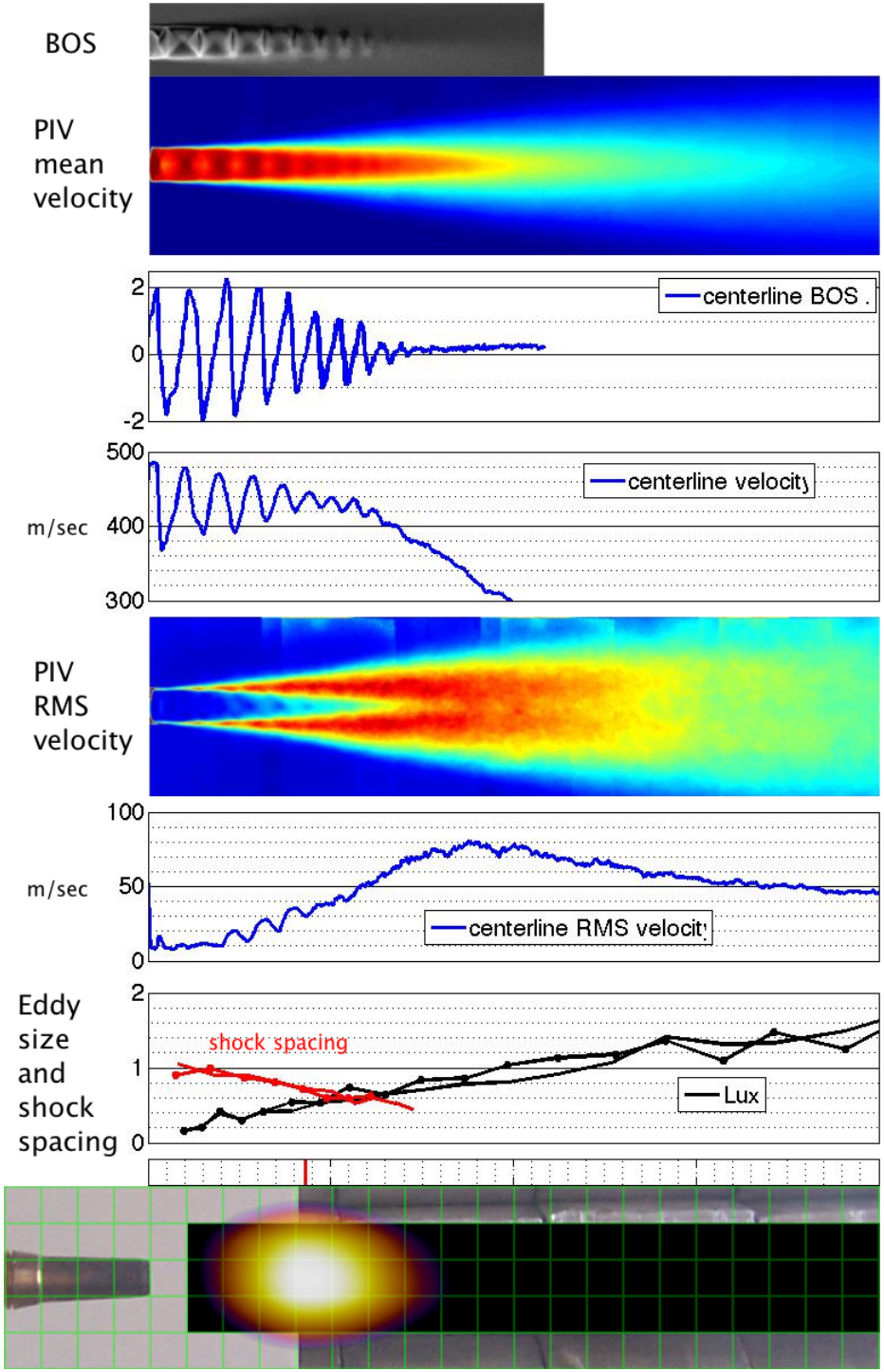

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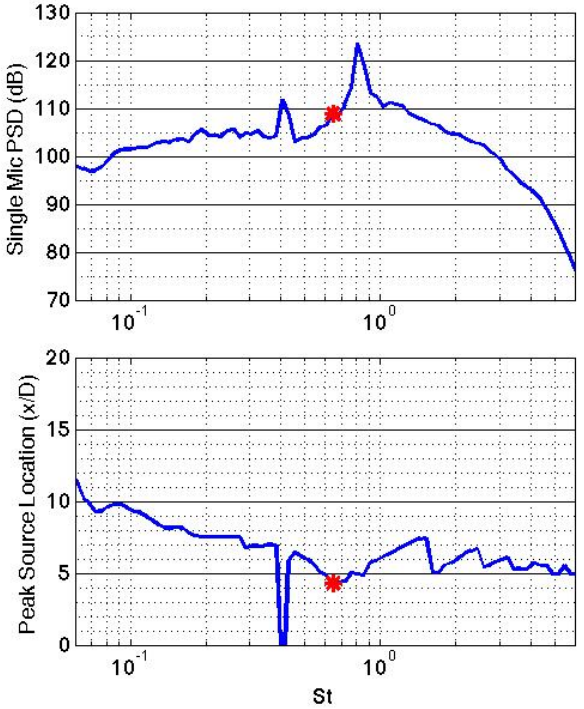

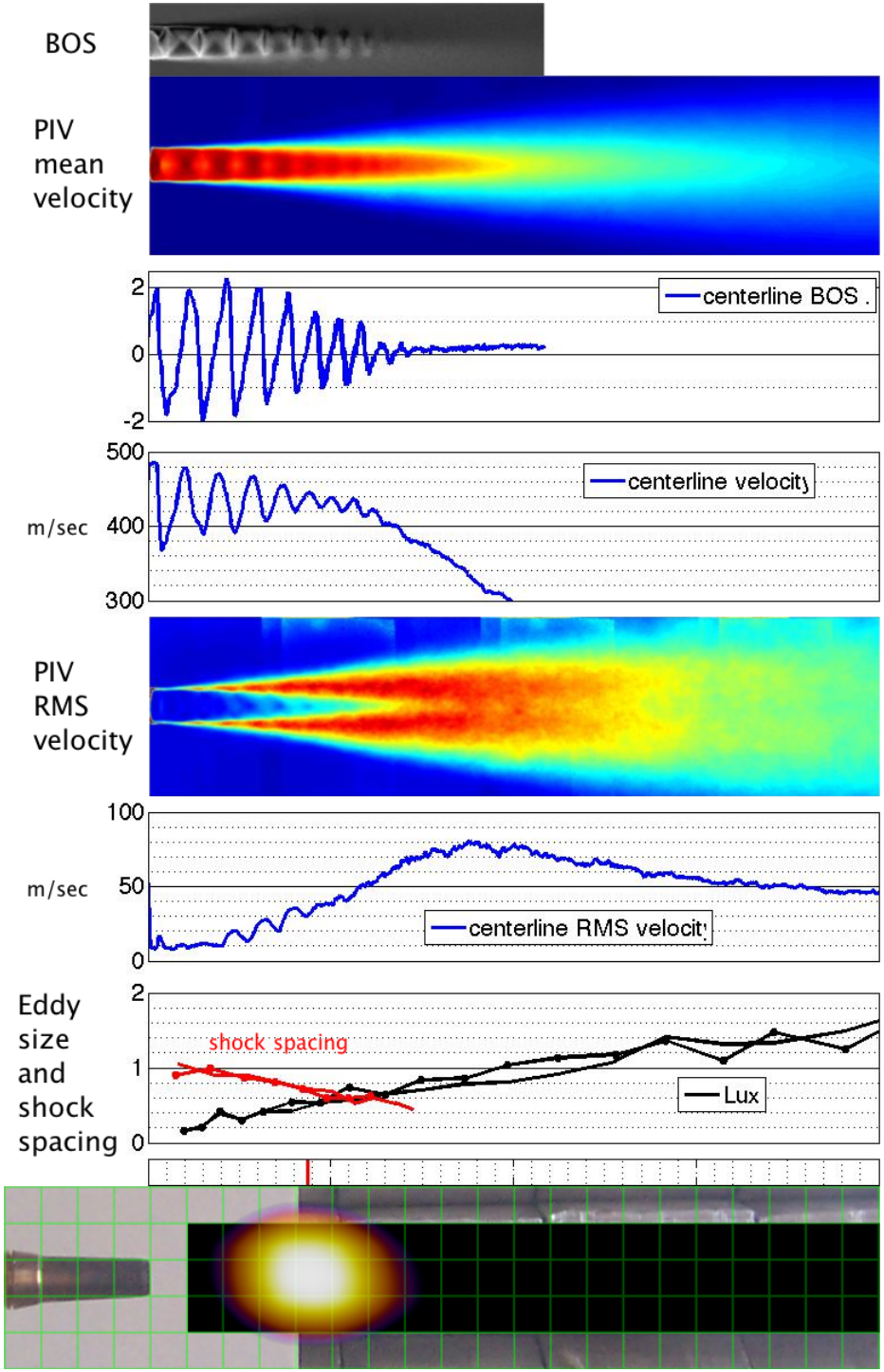

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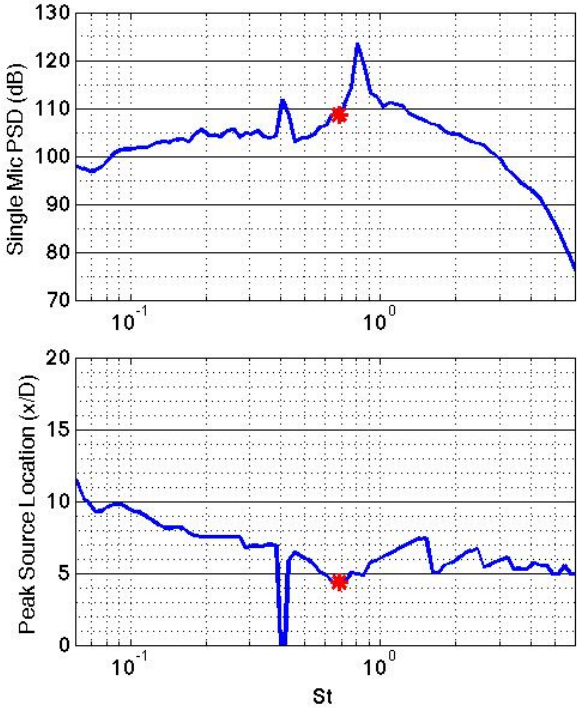

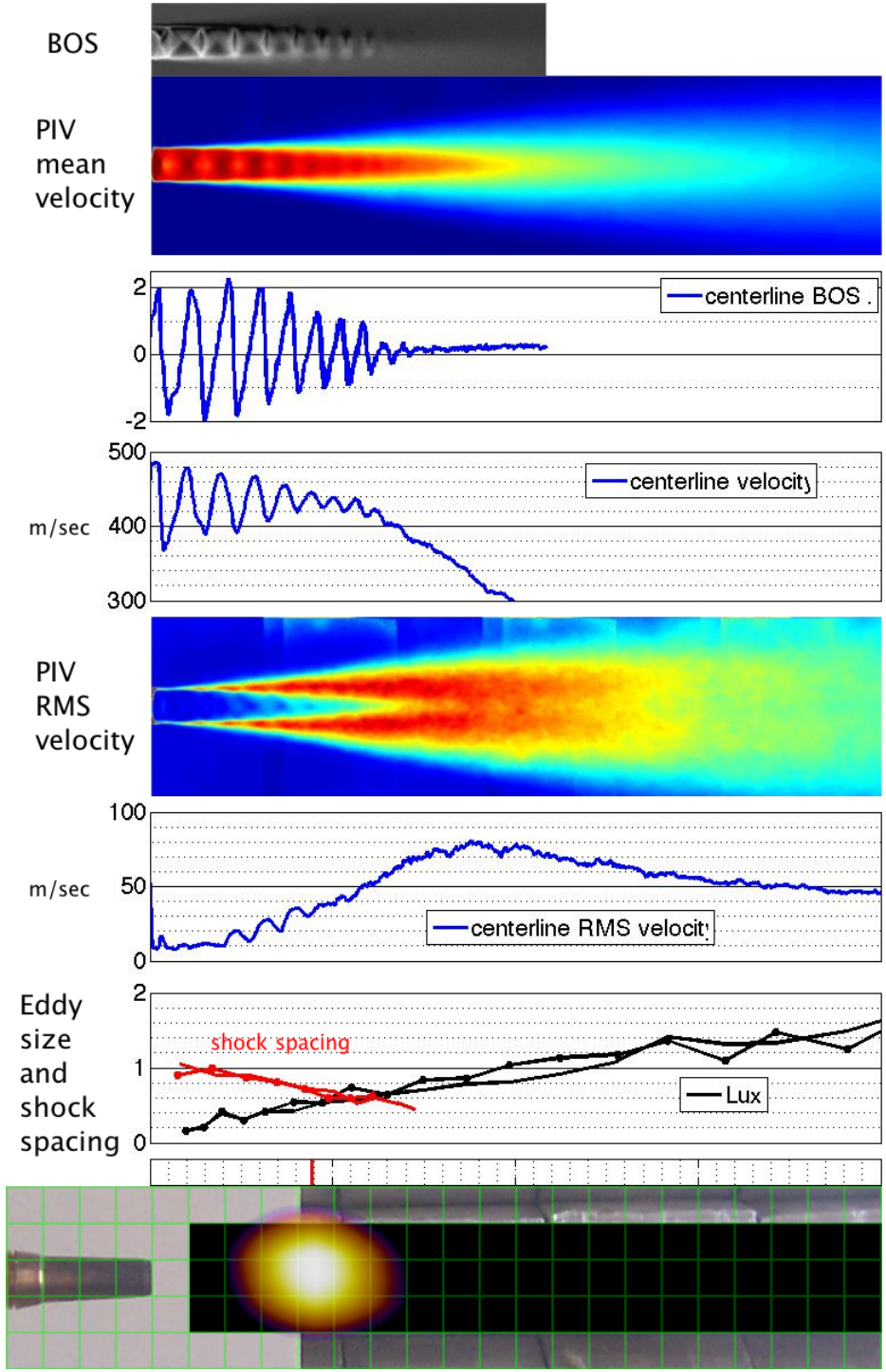

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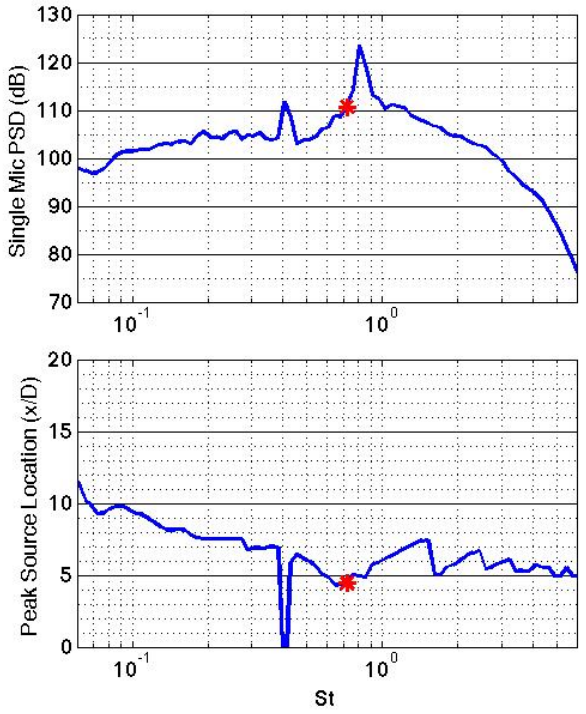

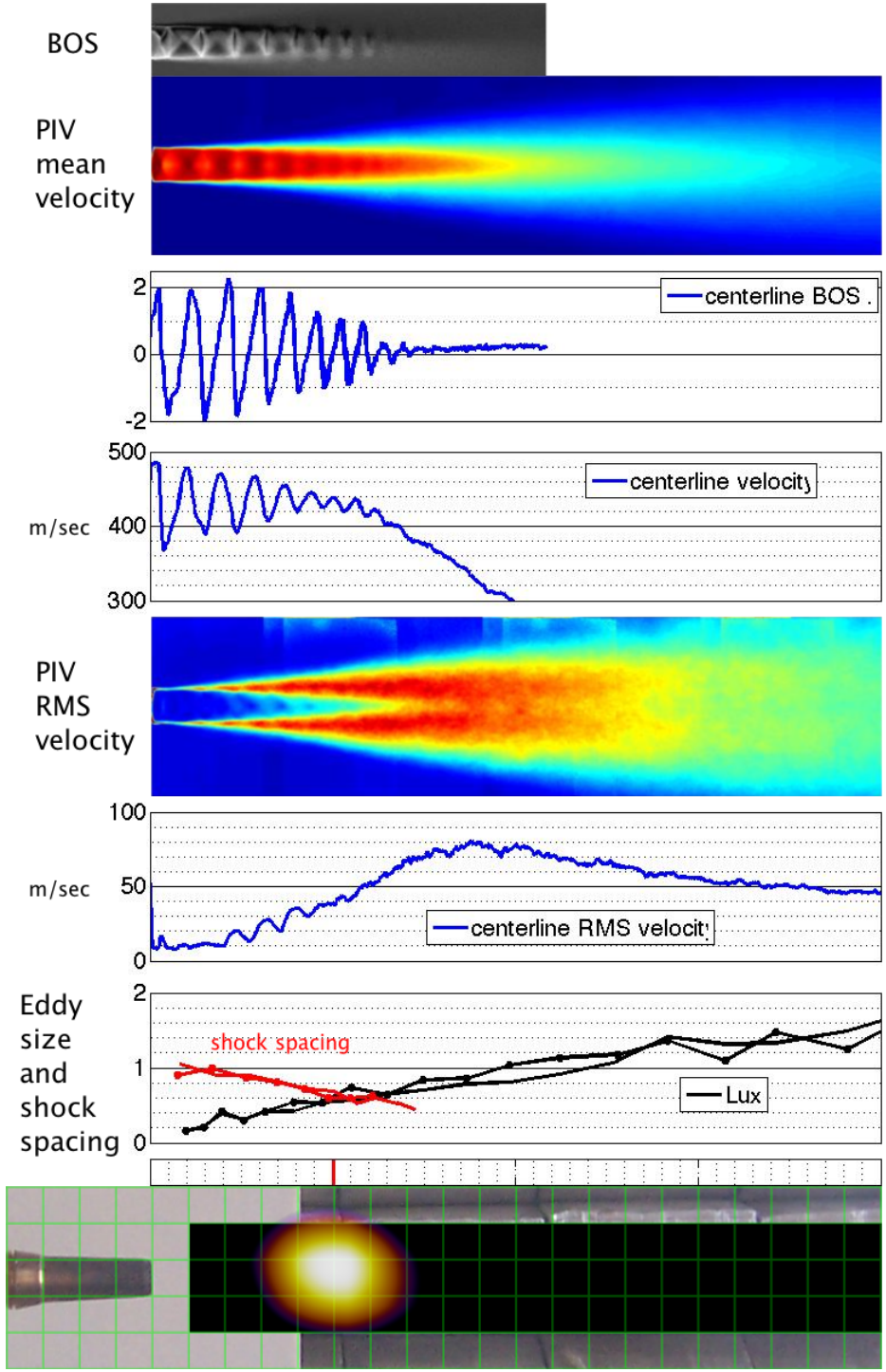

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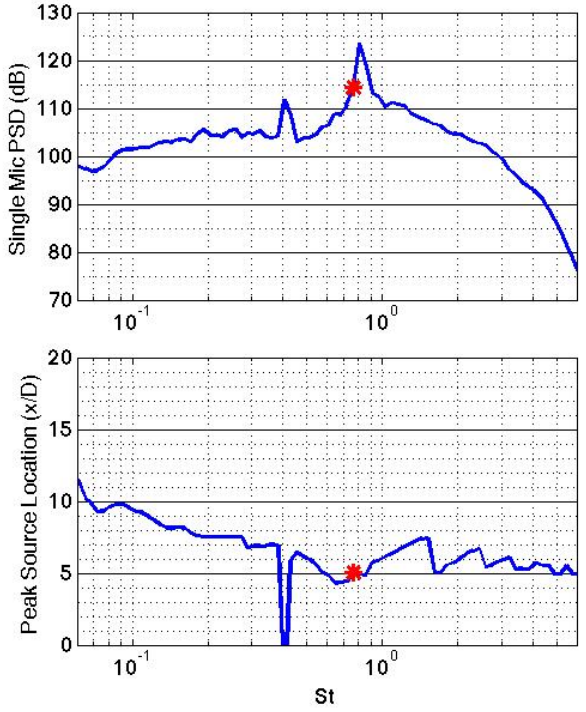

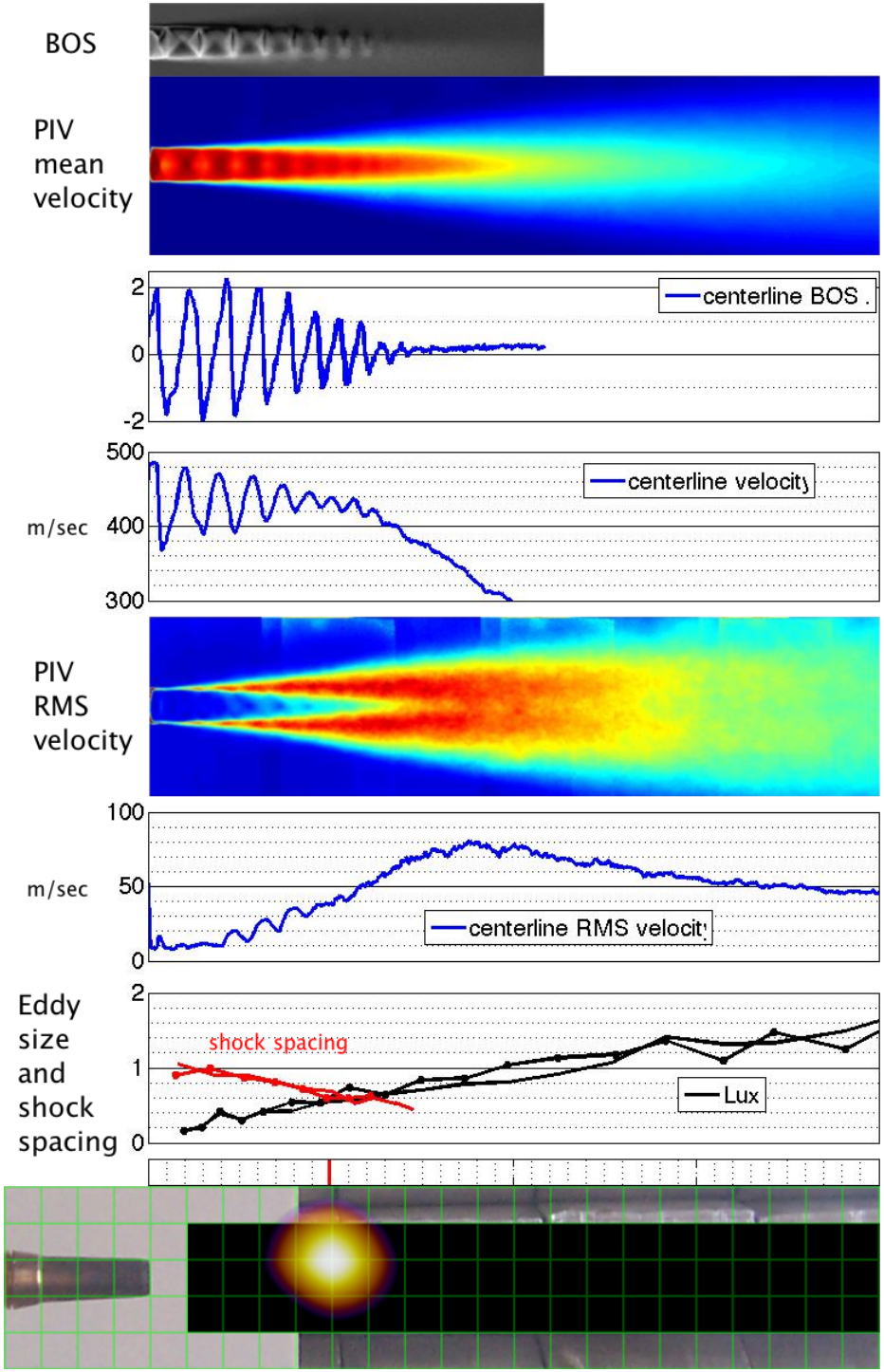

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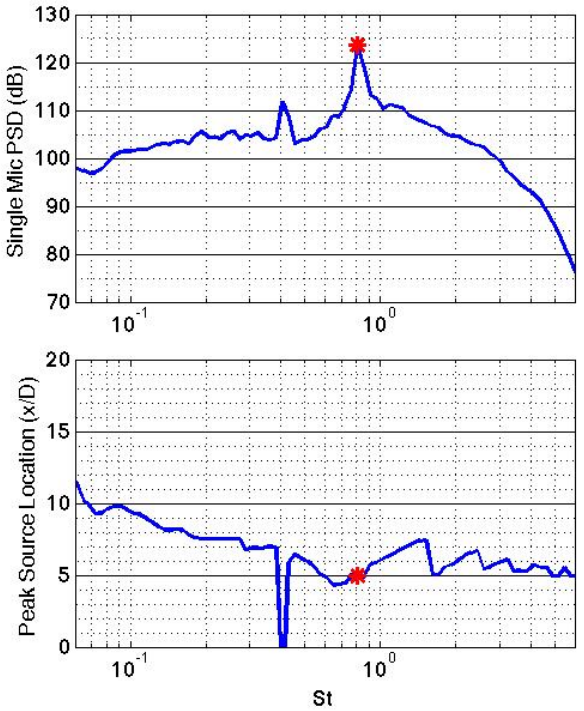

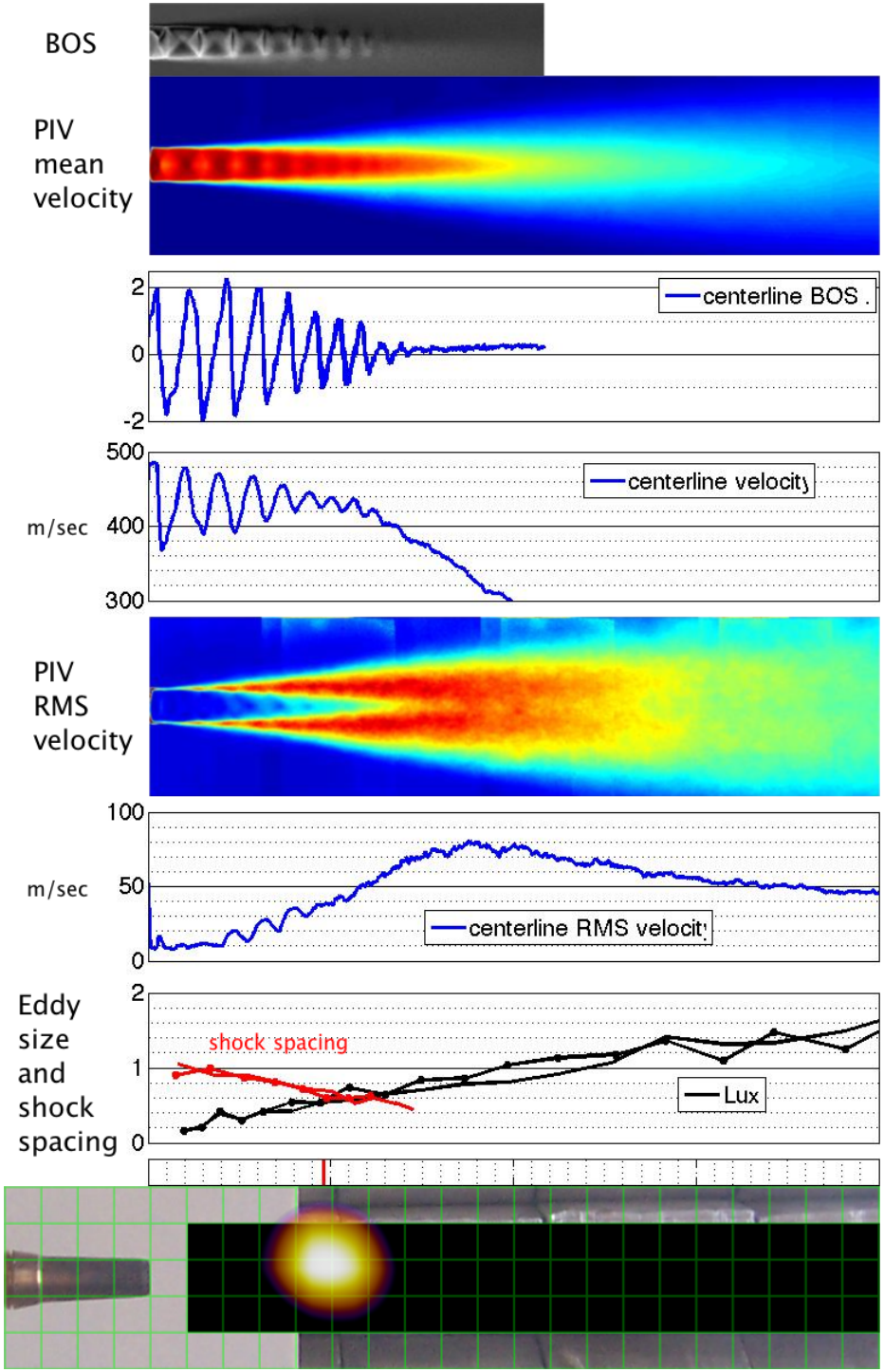

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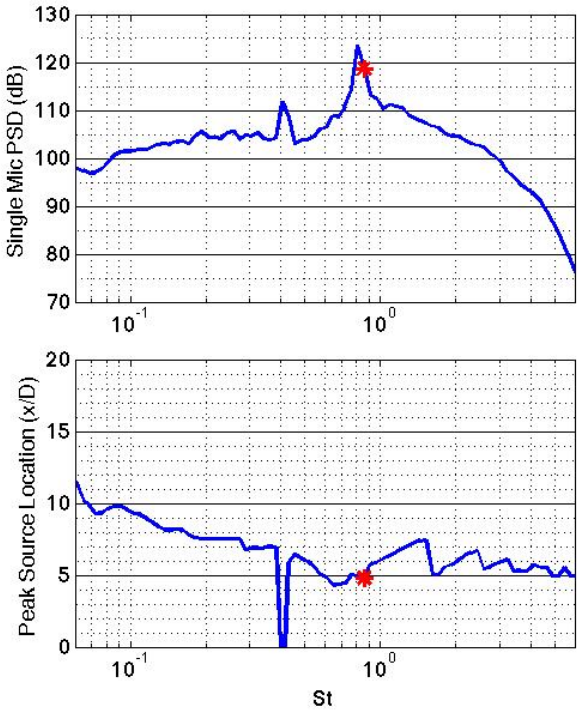

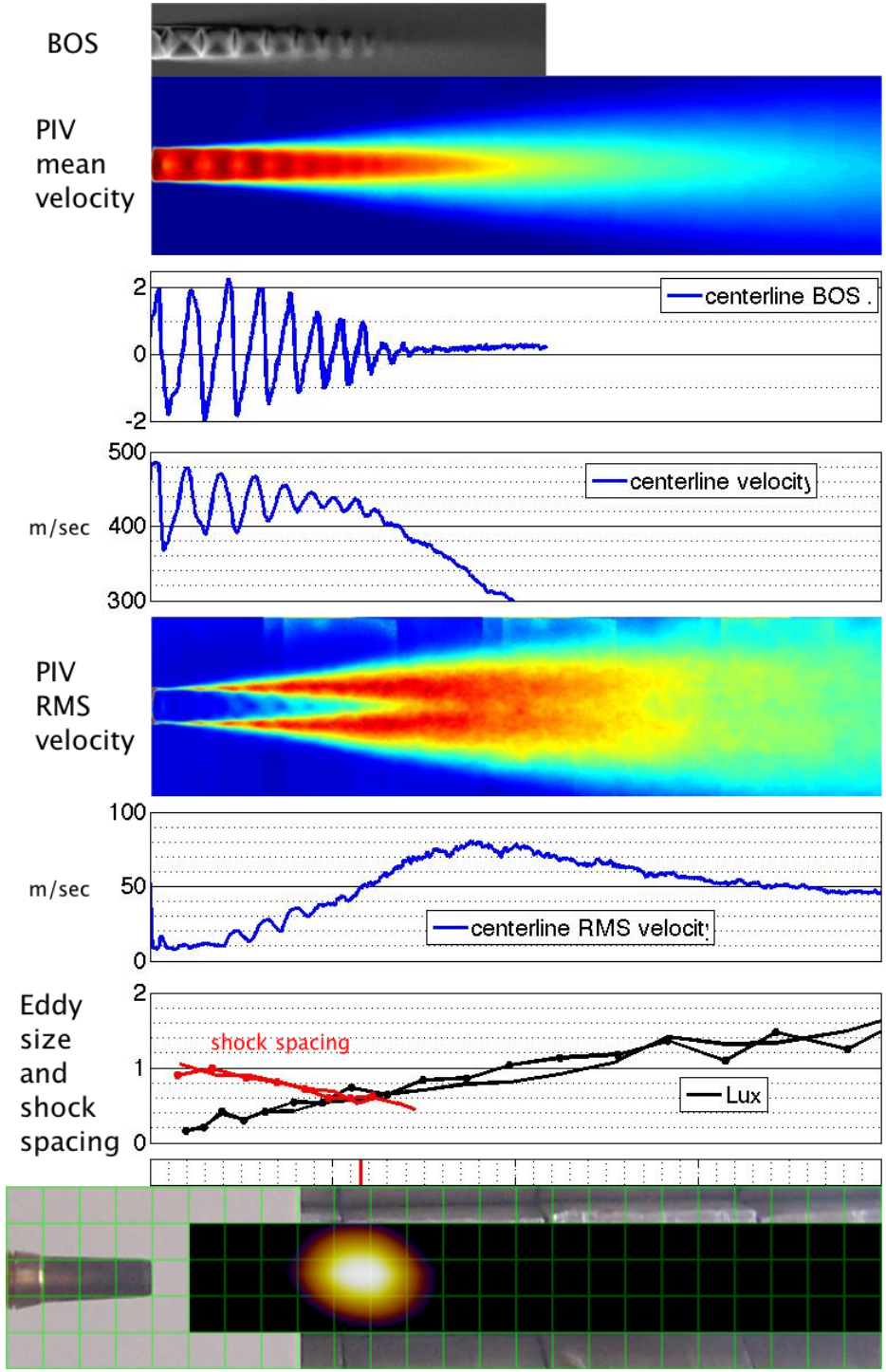

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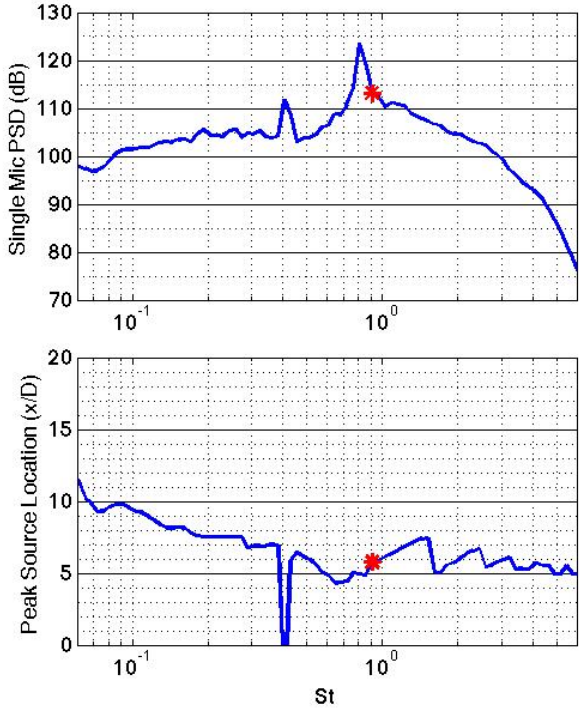

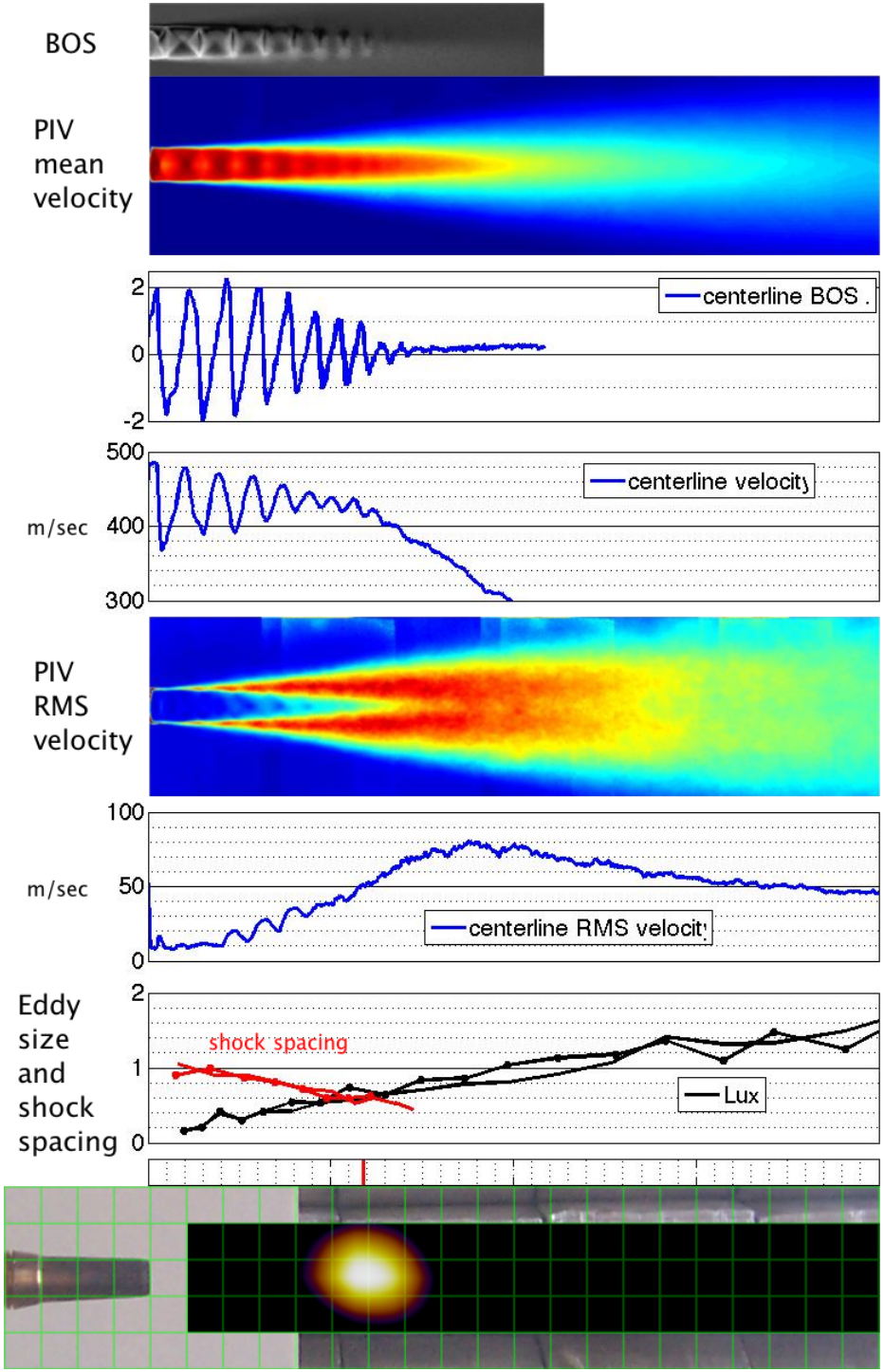

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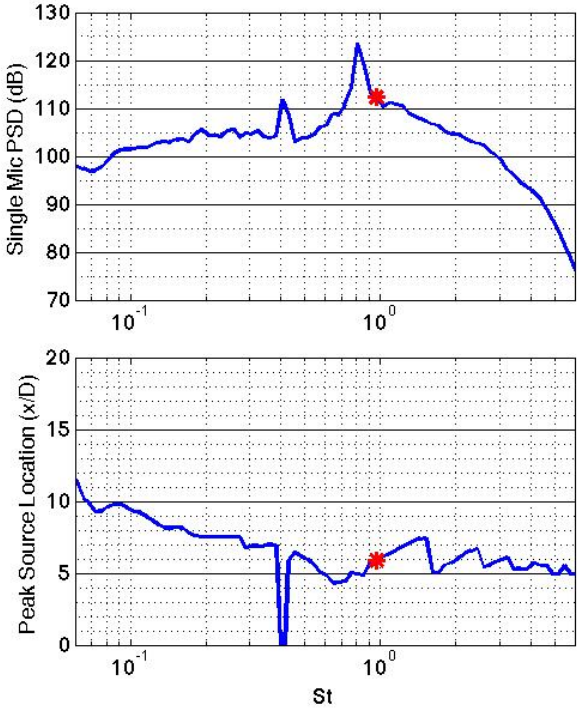

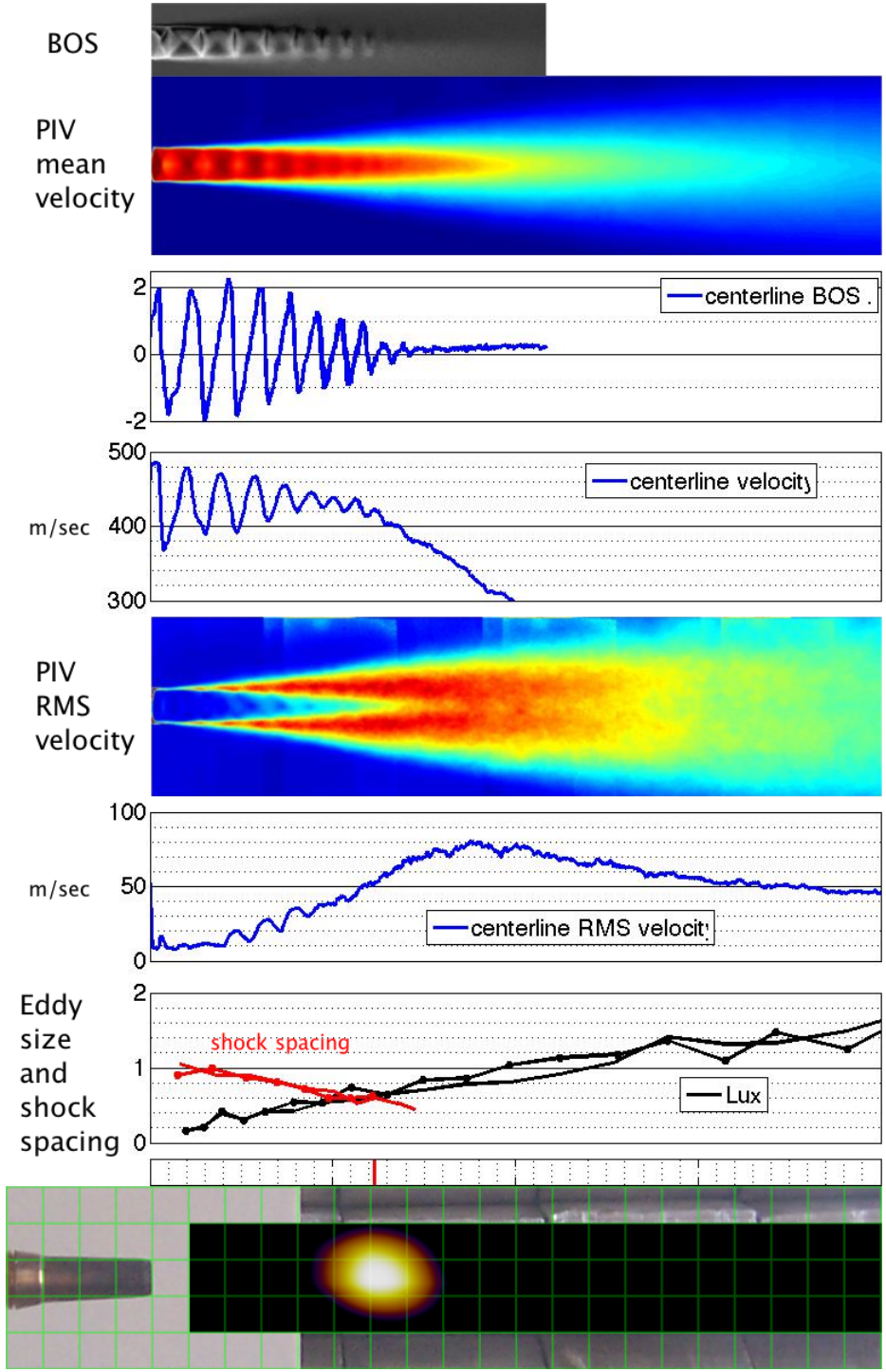

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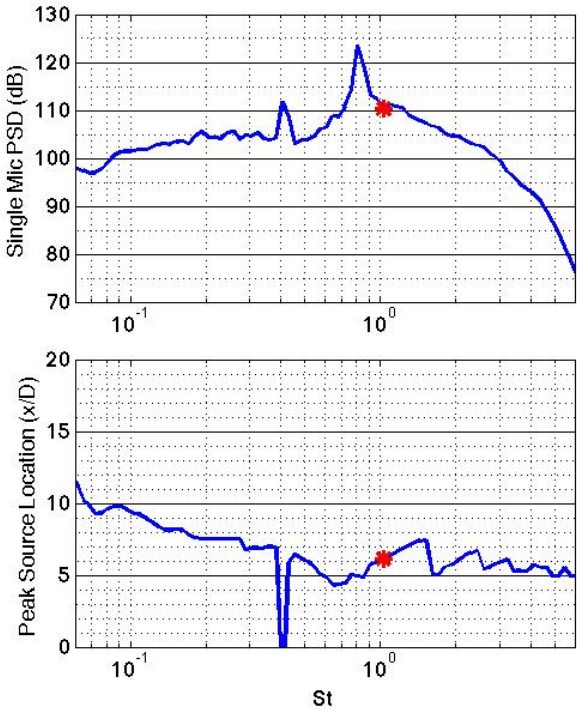

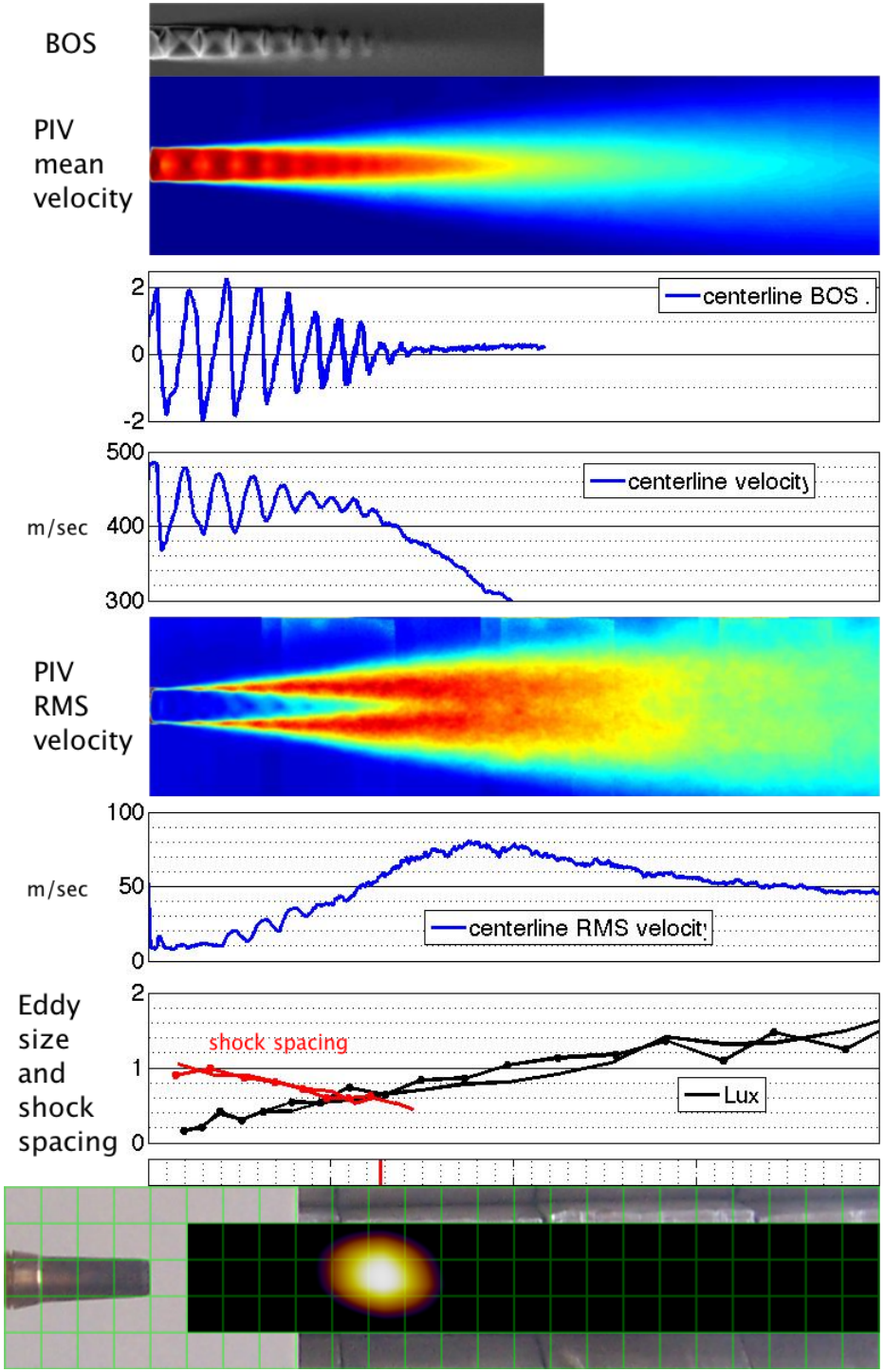

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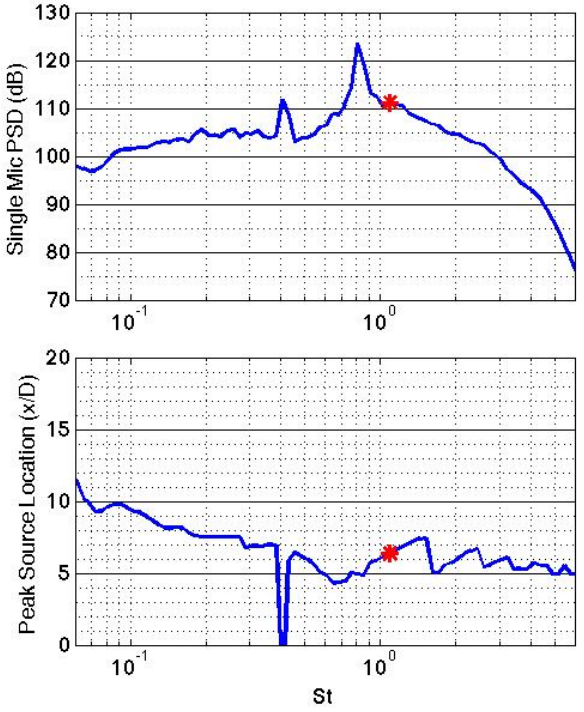

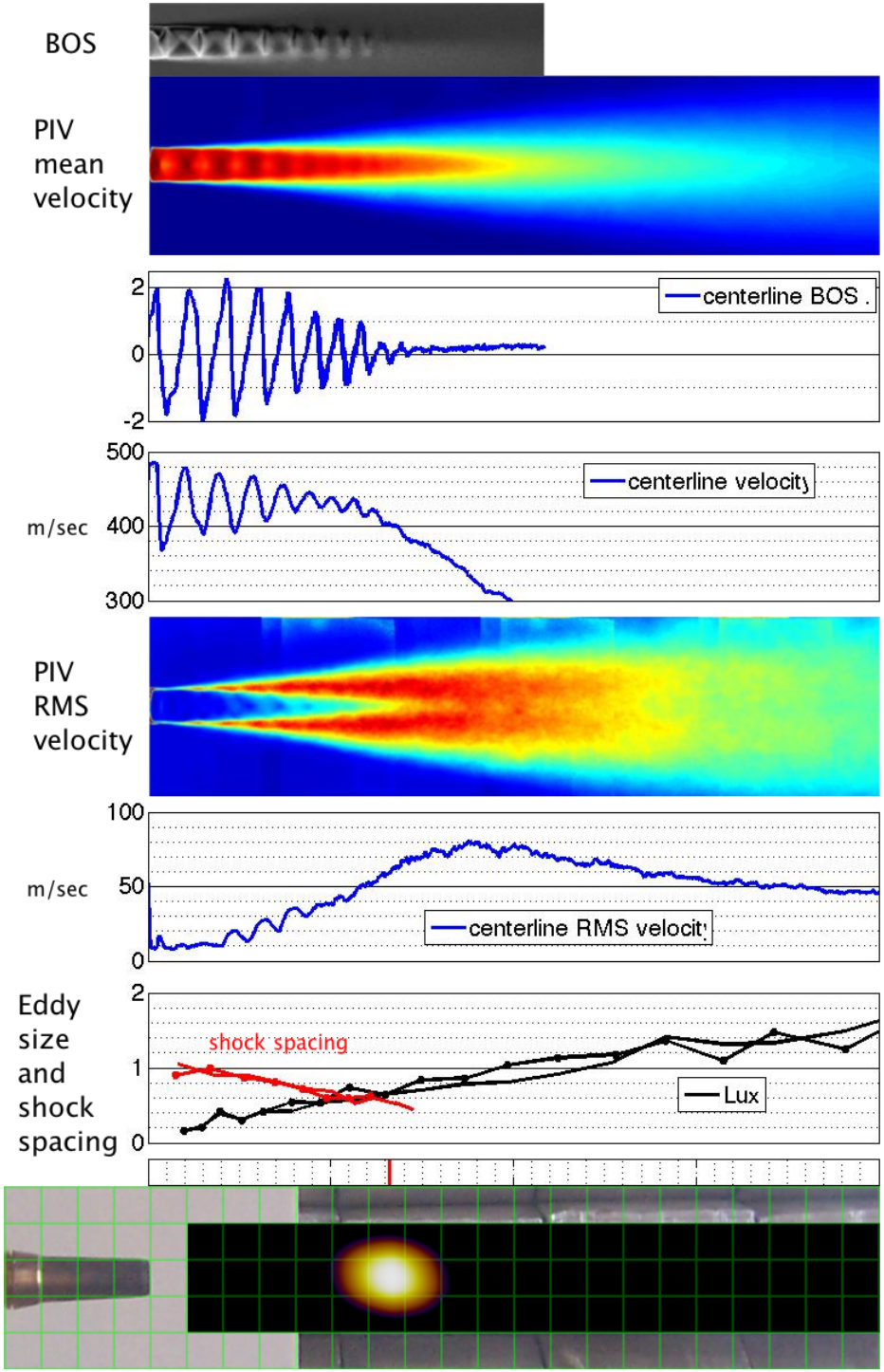

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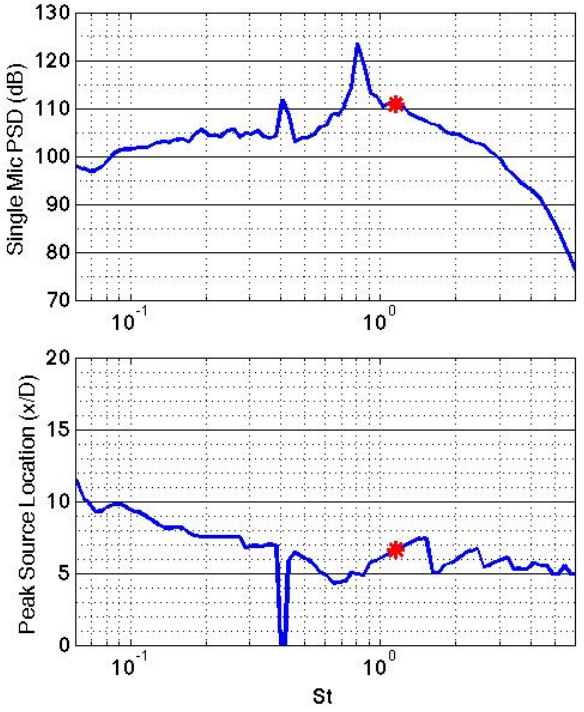

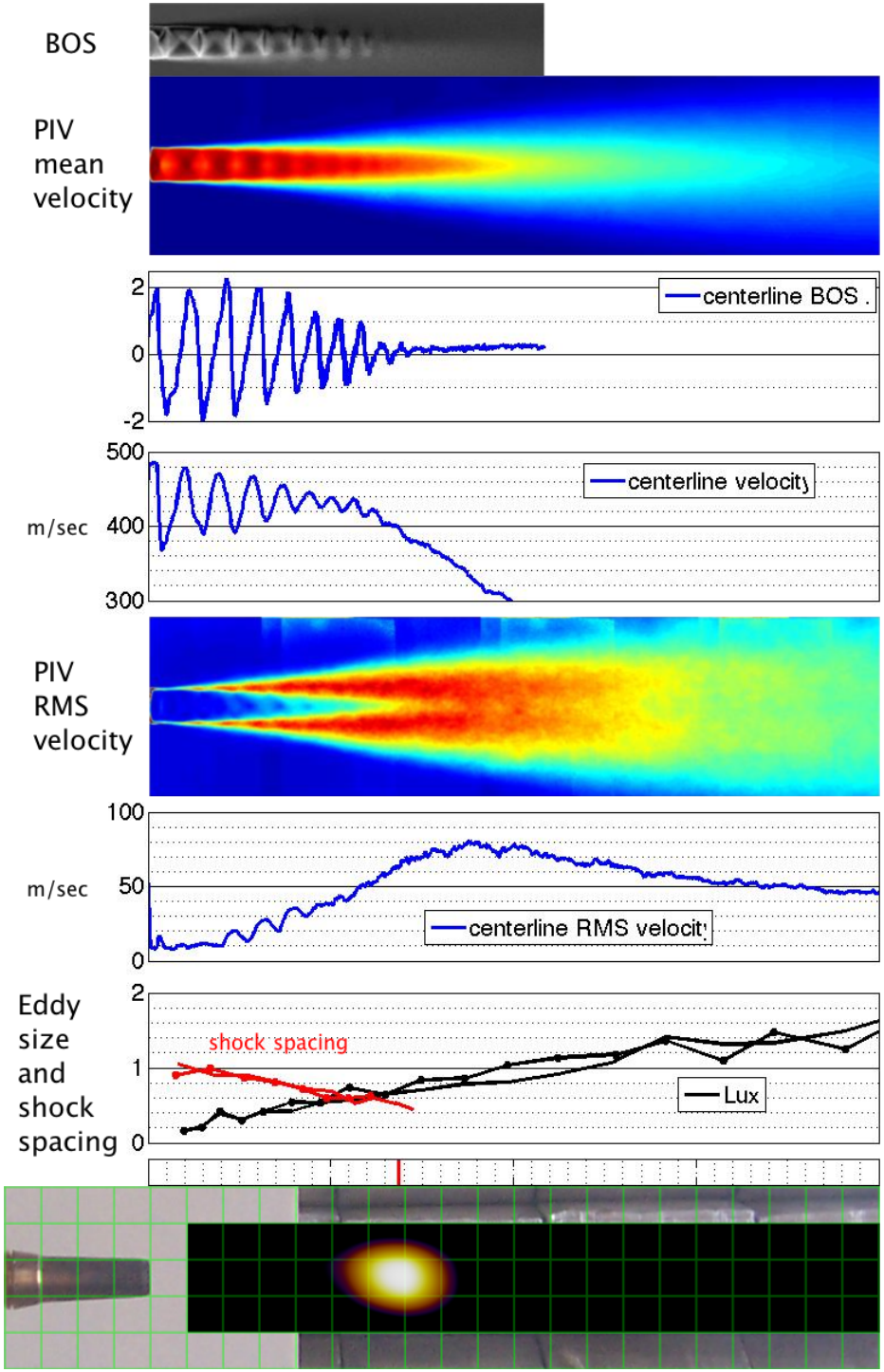

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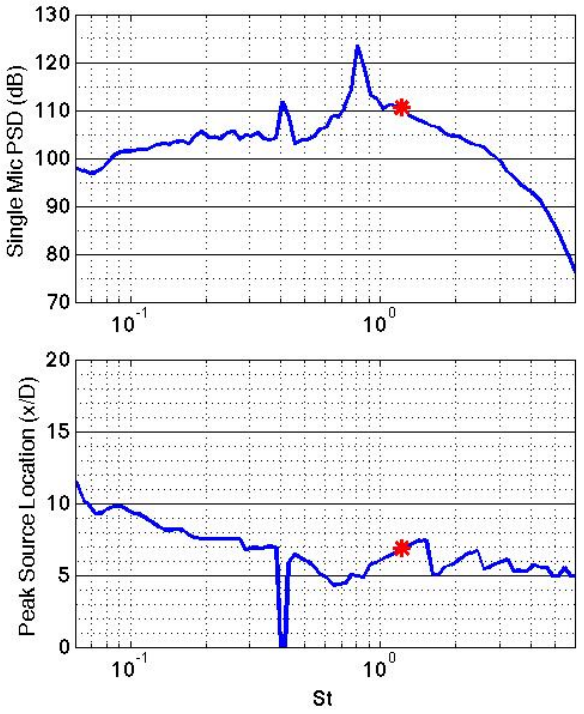

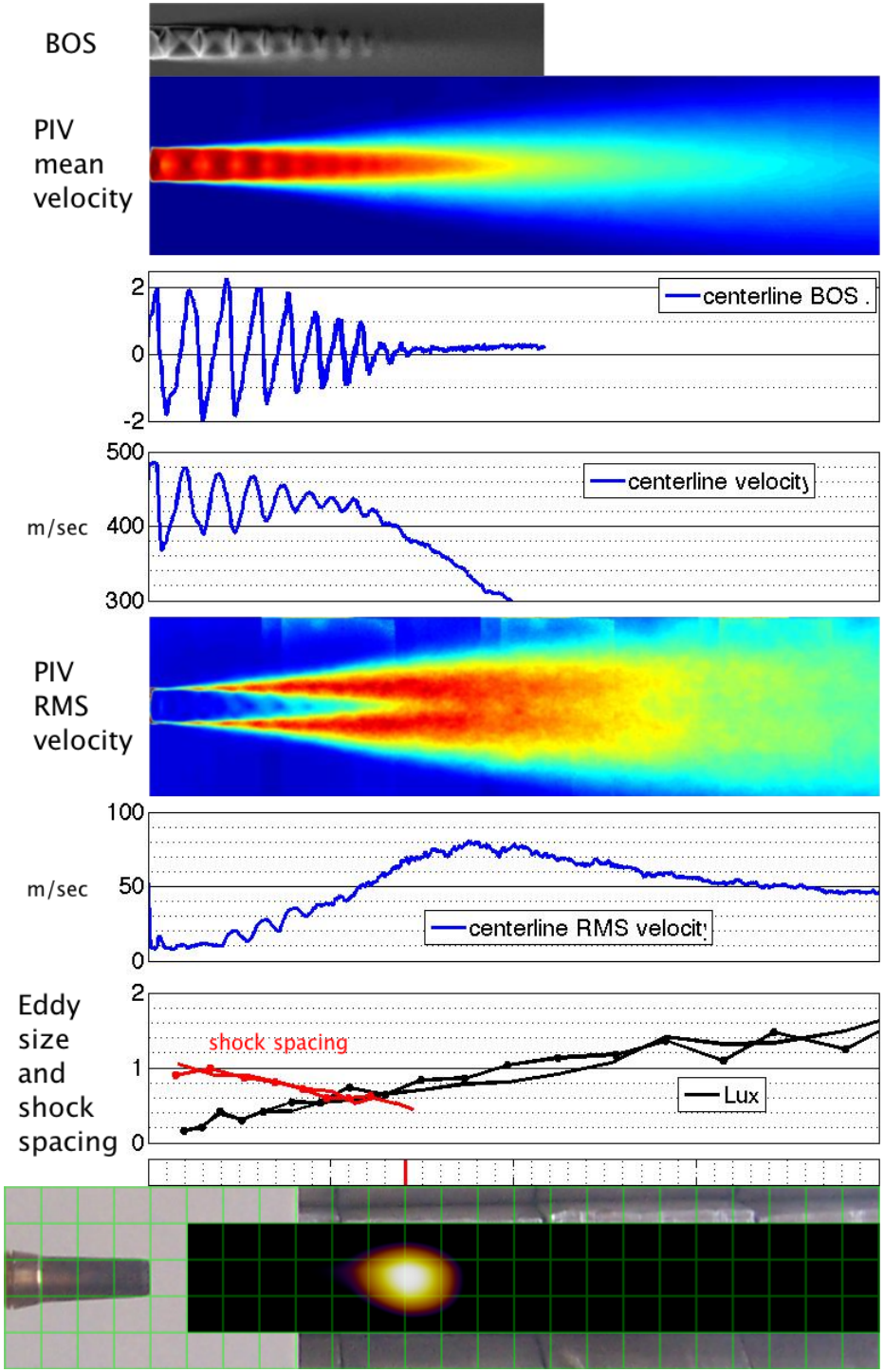

SMC016

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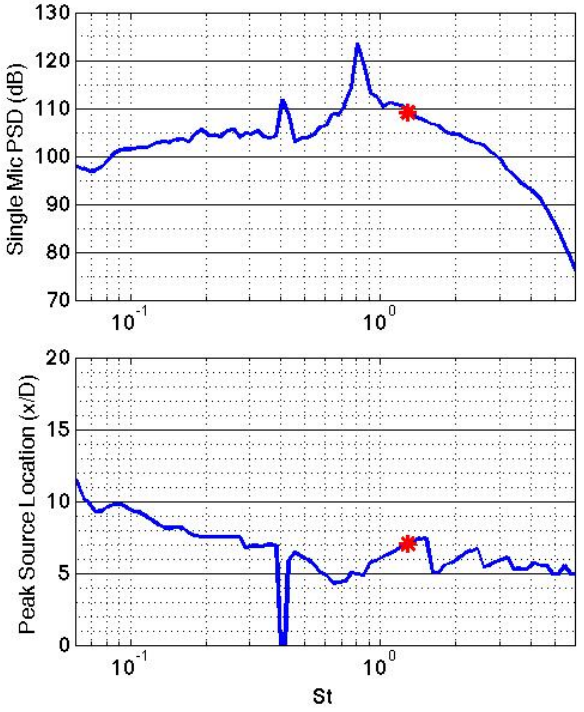

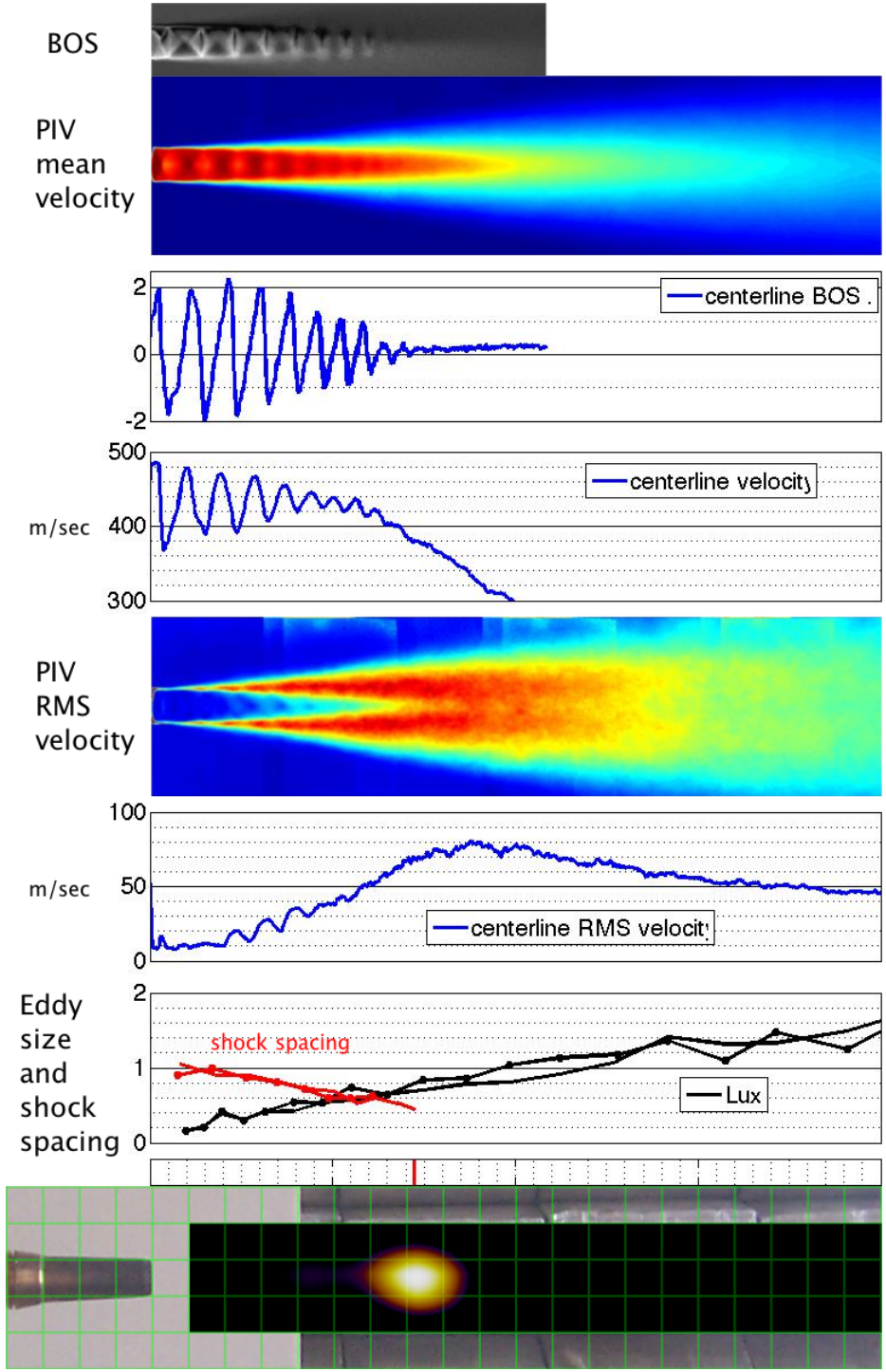

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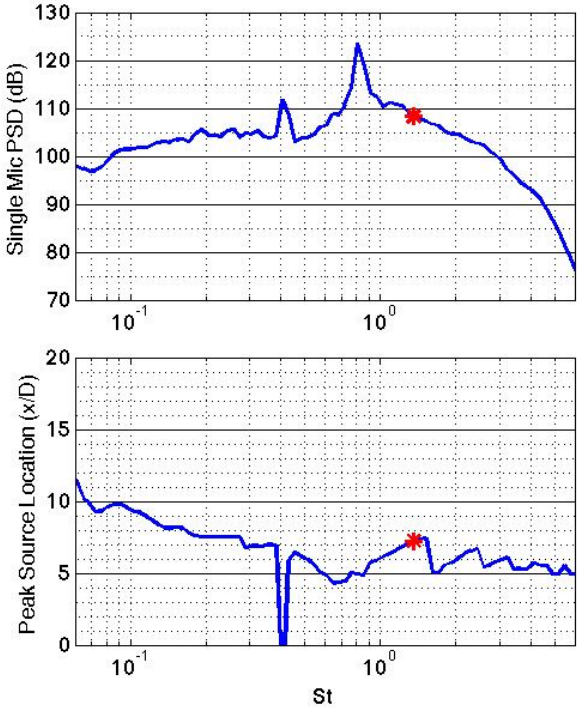

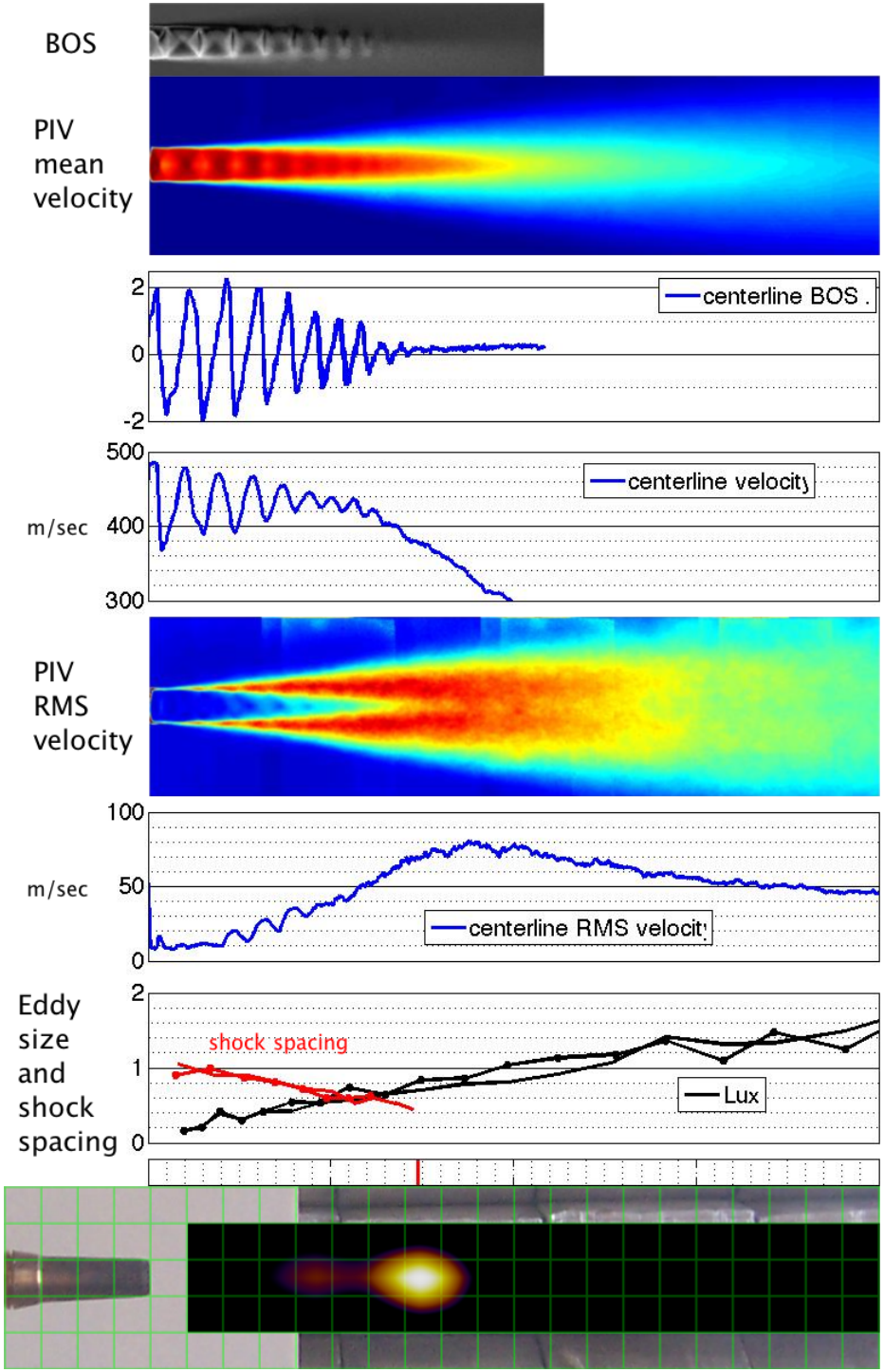

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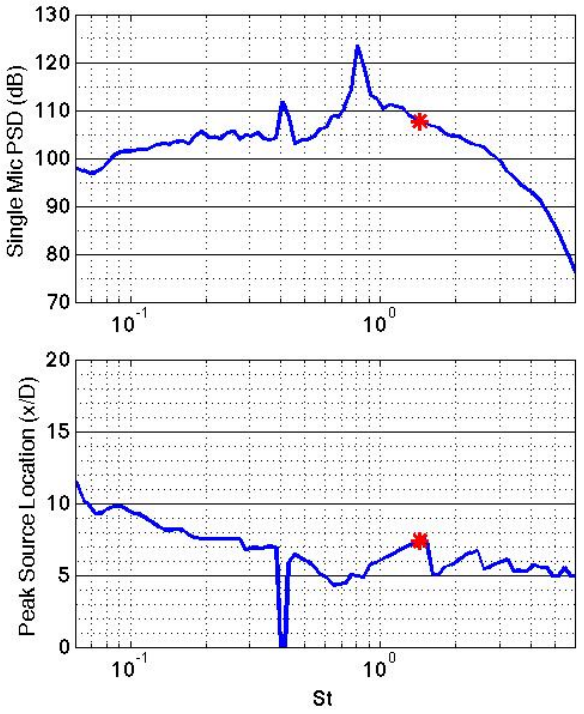

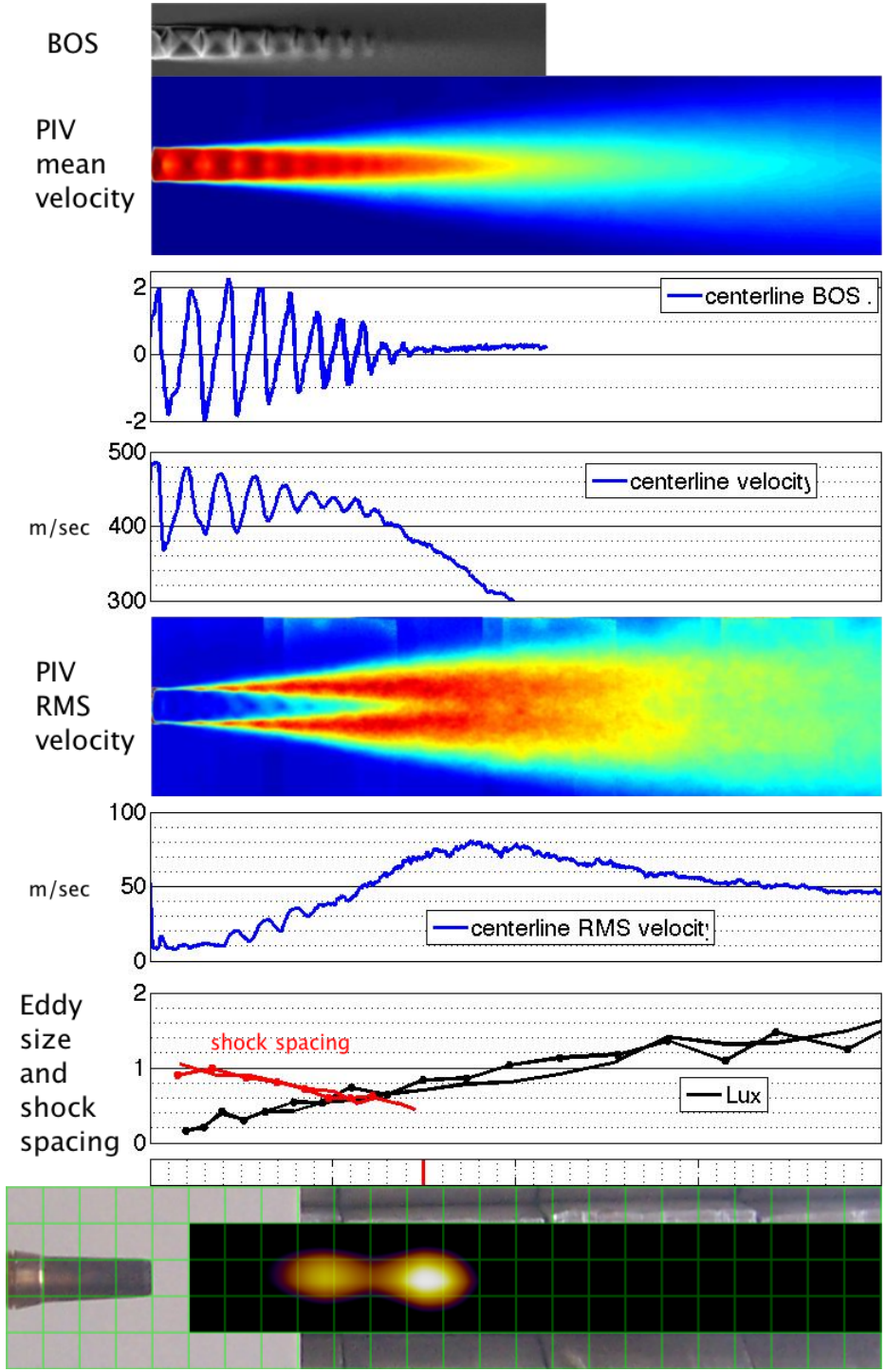

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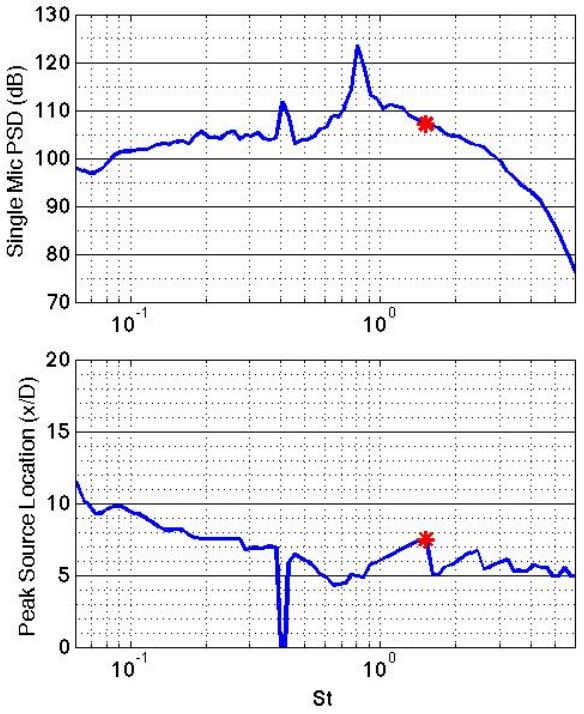

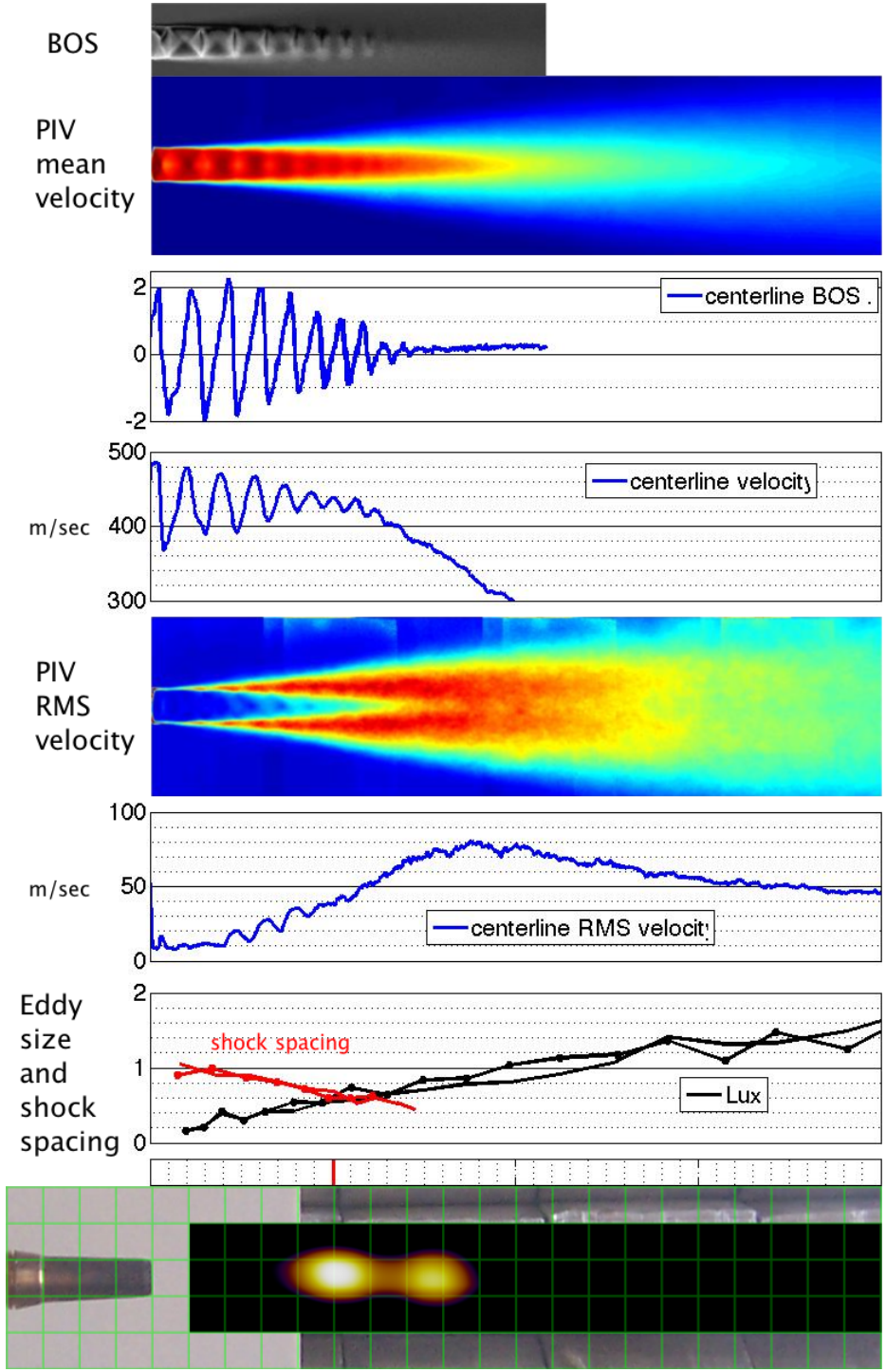

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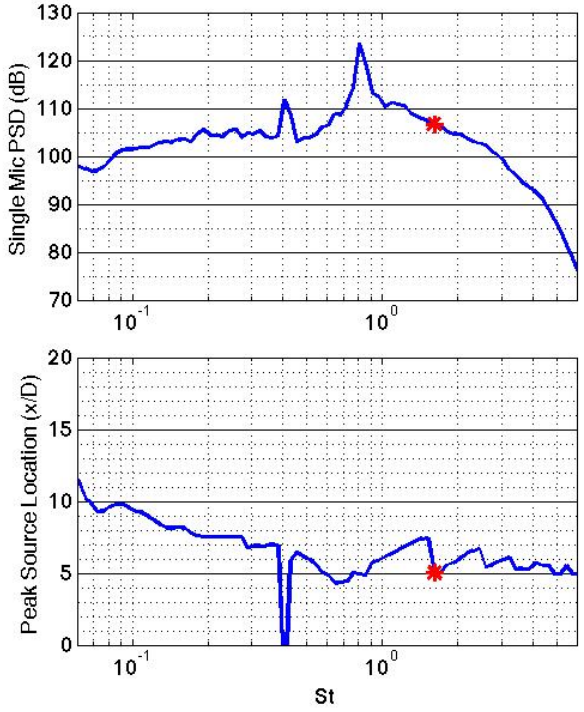

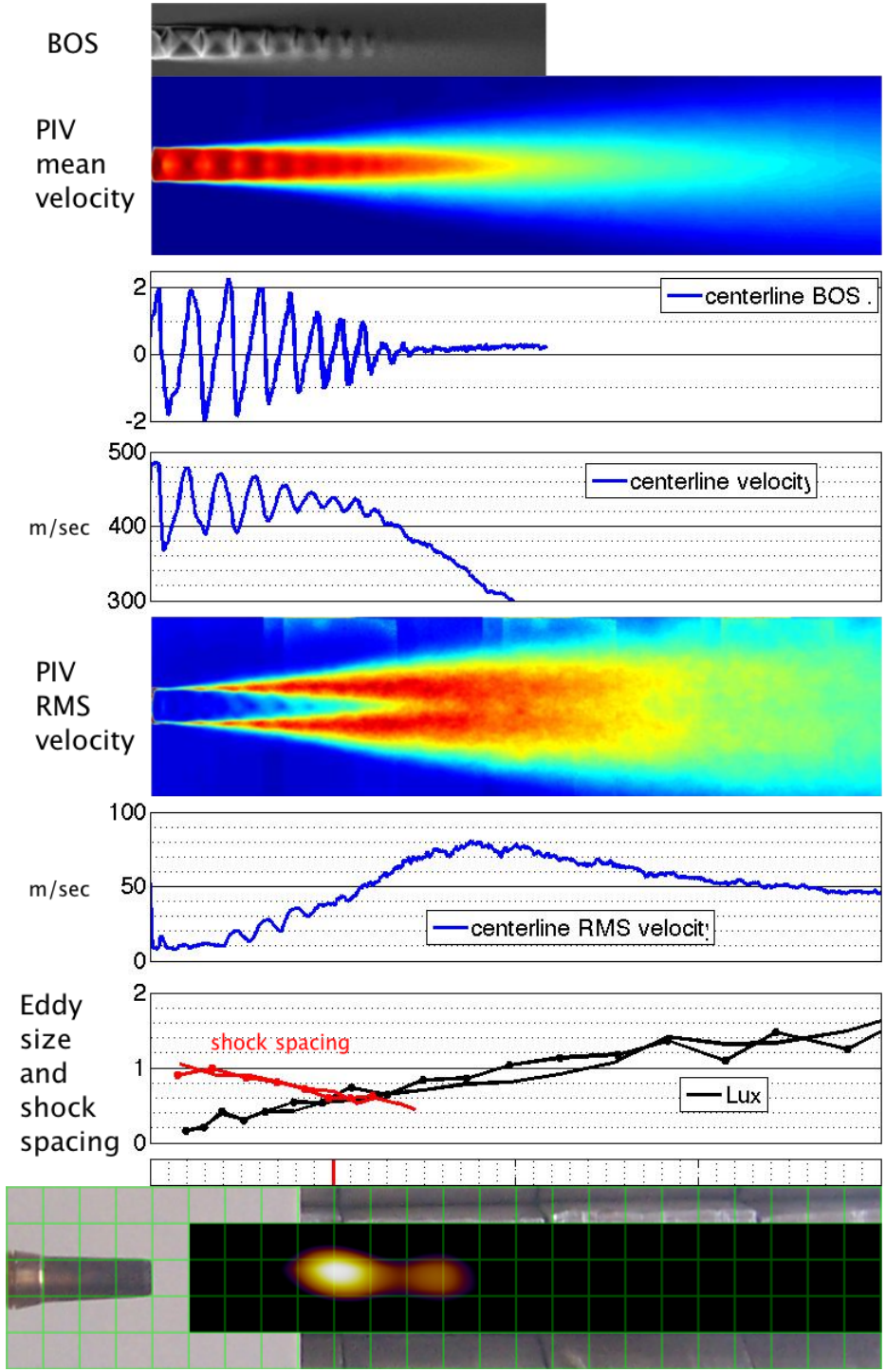

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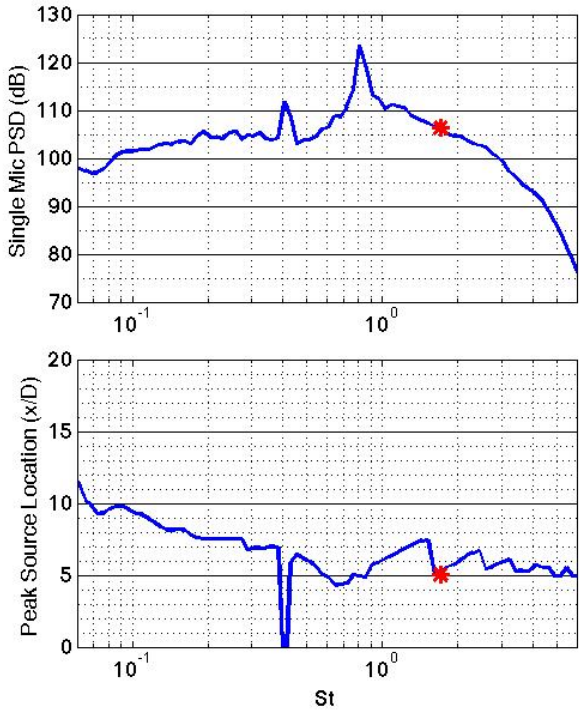

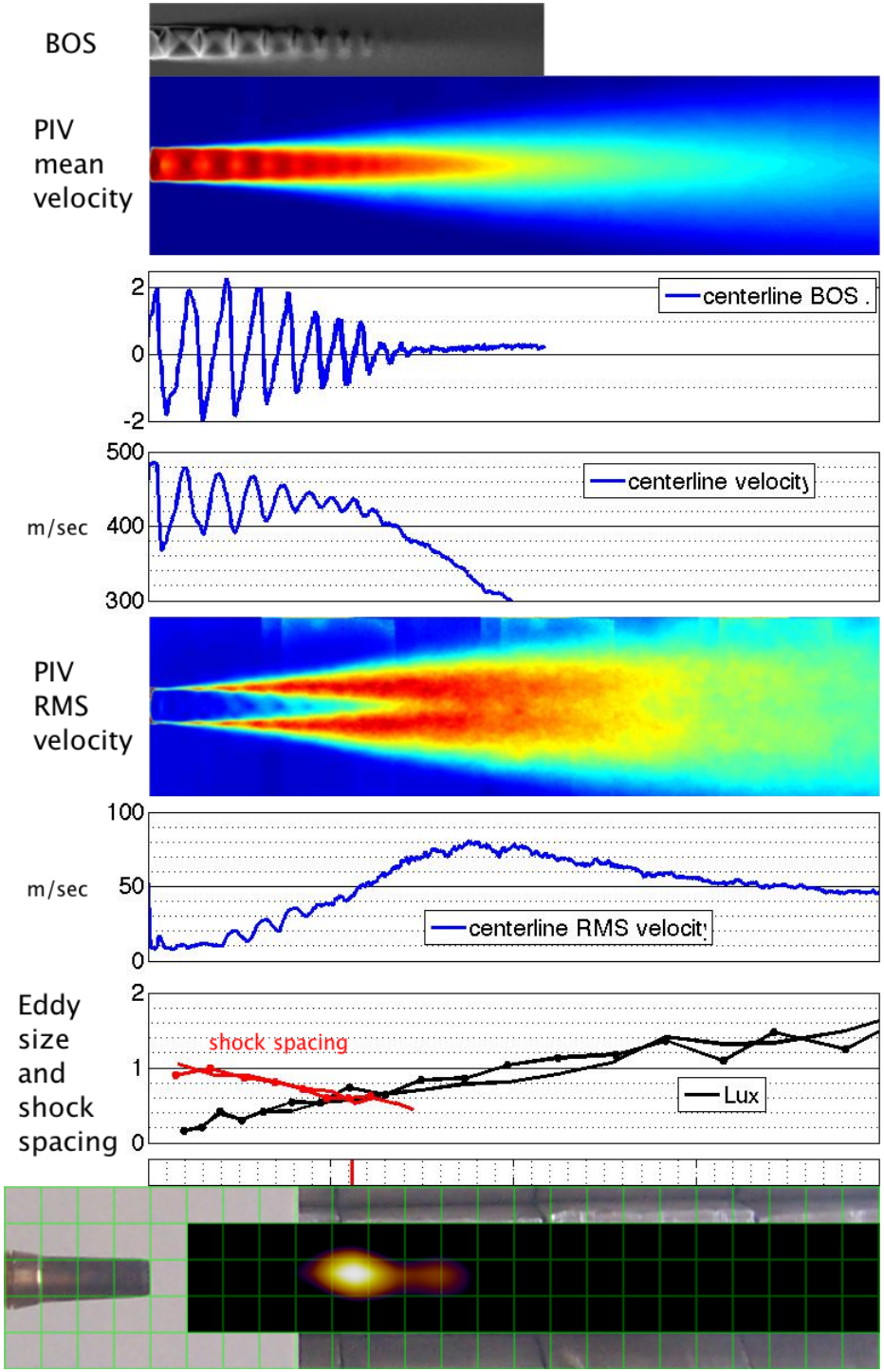

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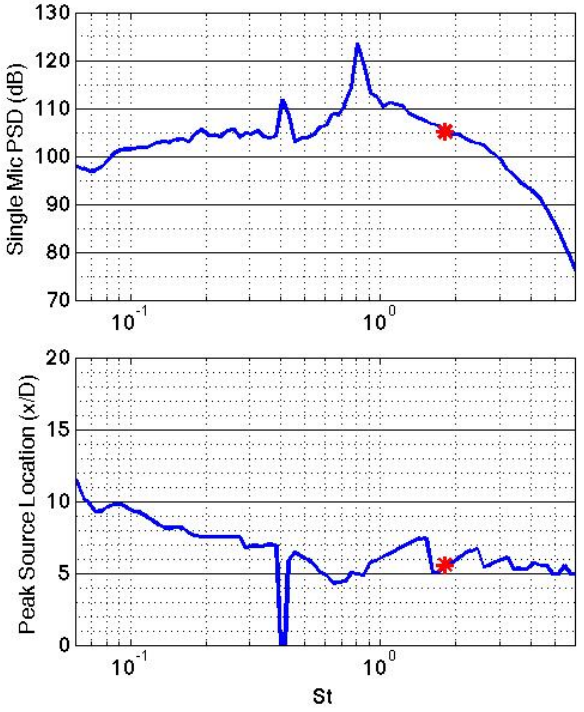

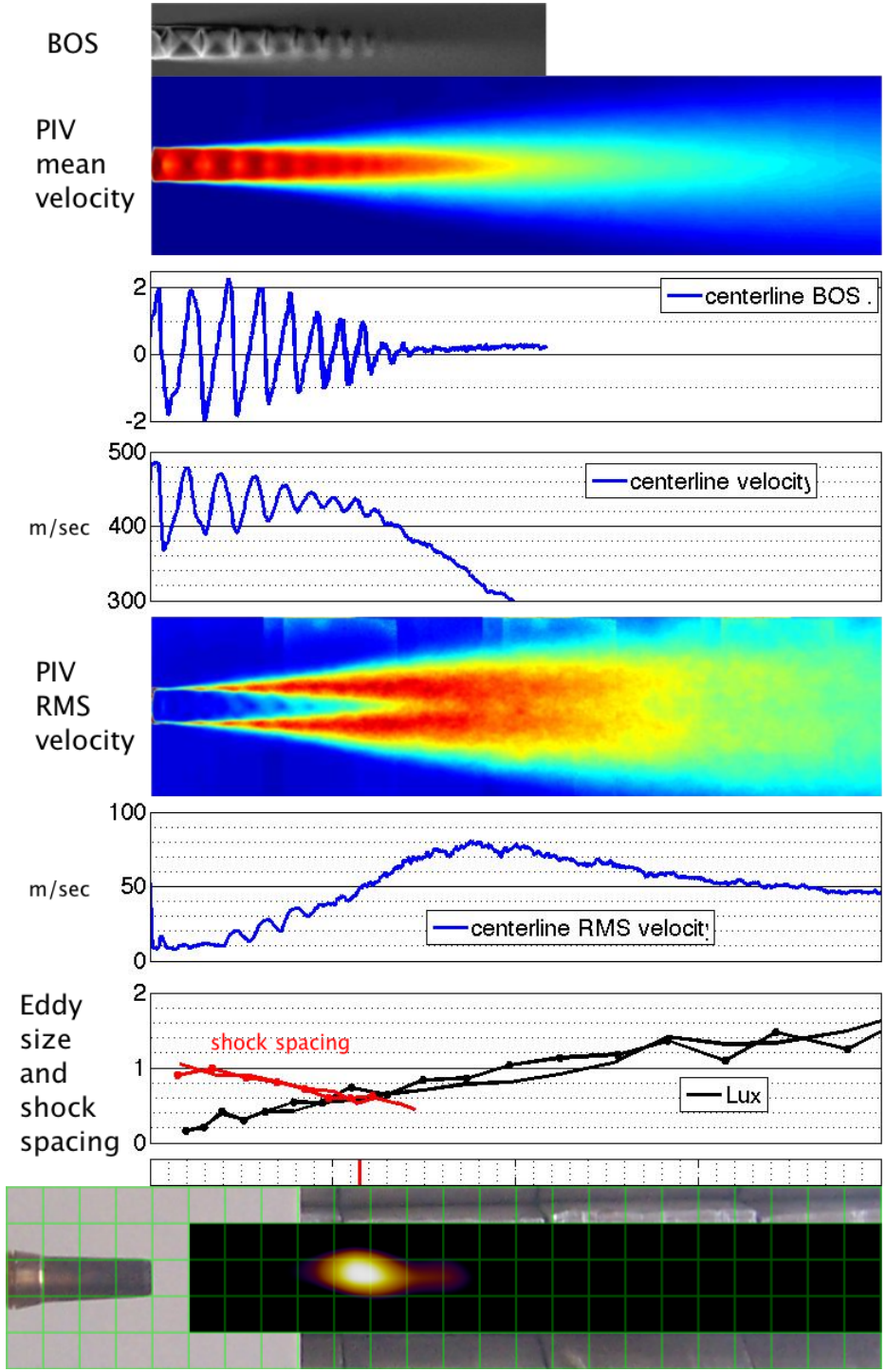

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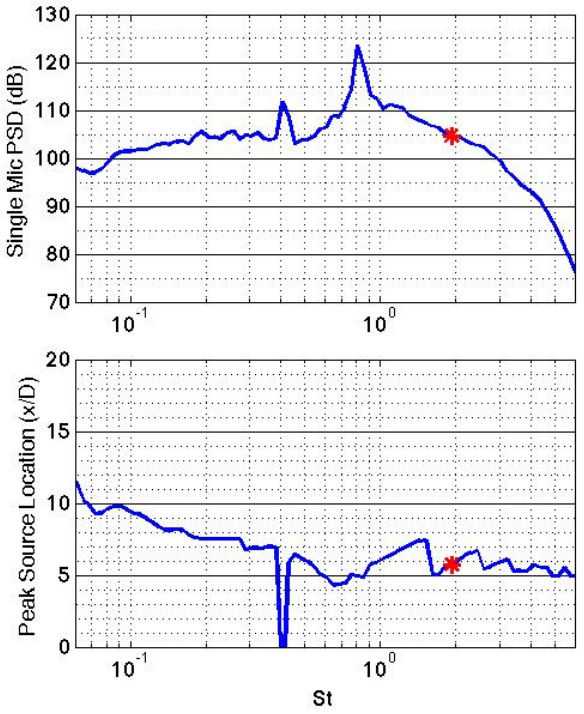

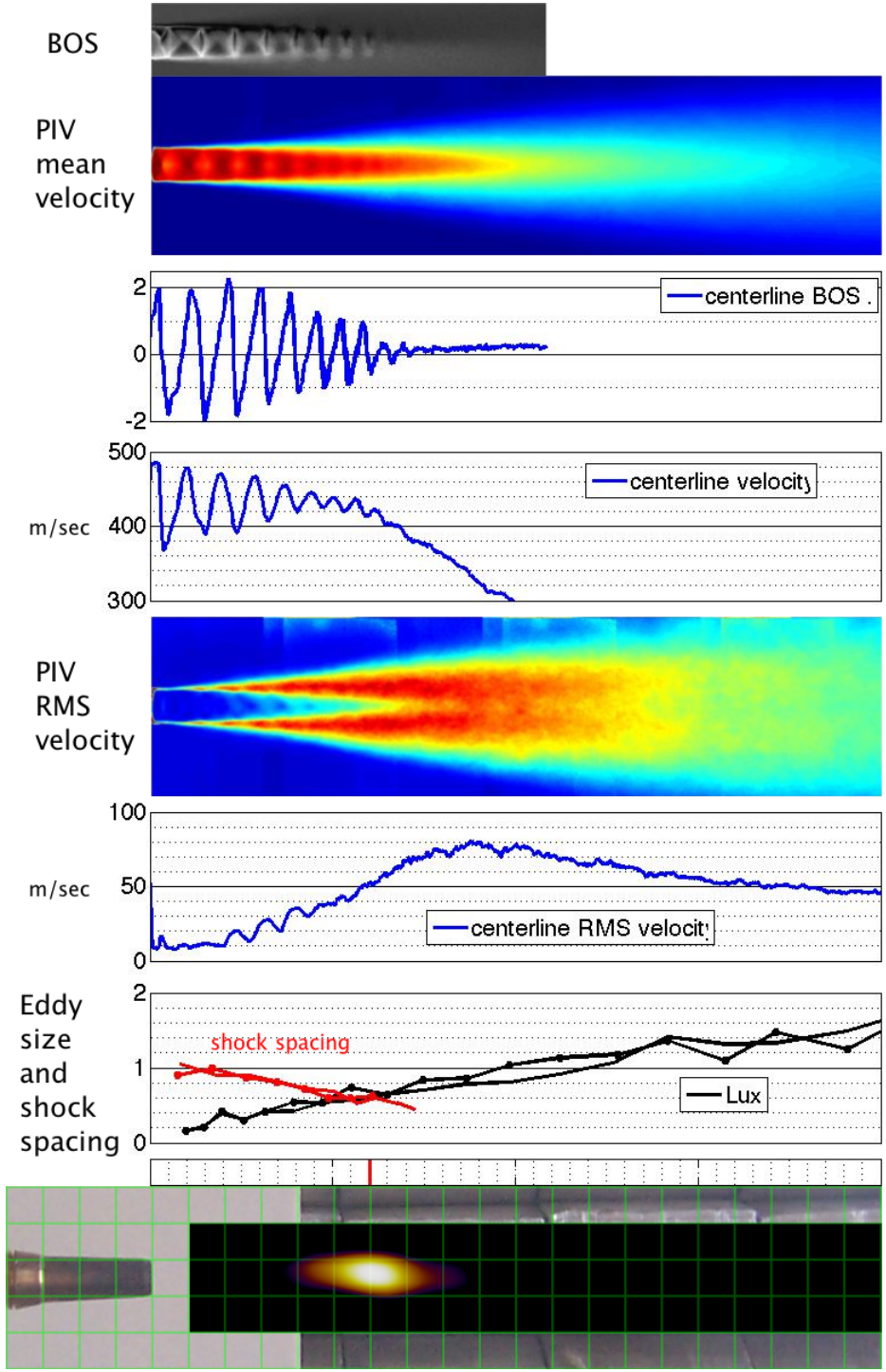

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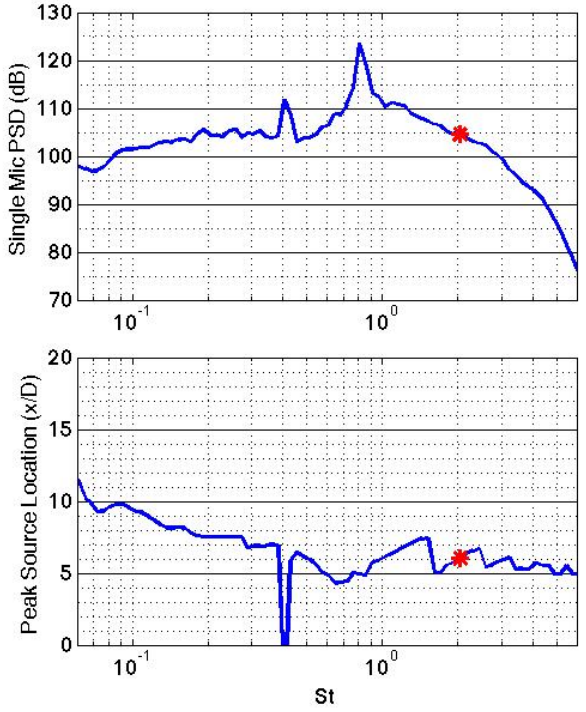

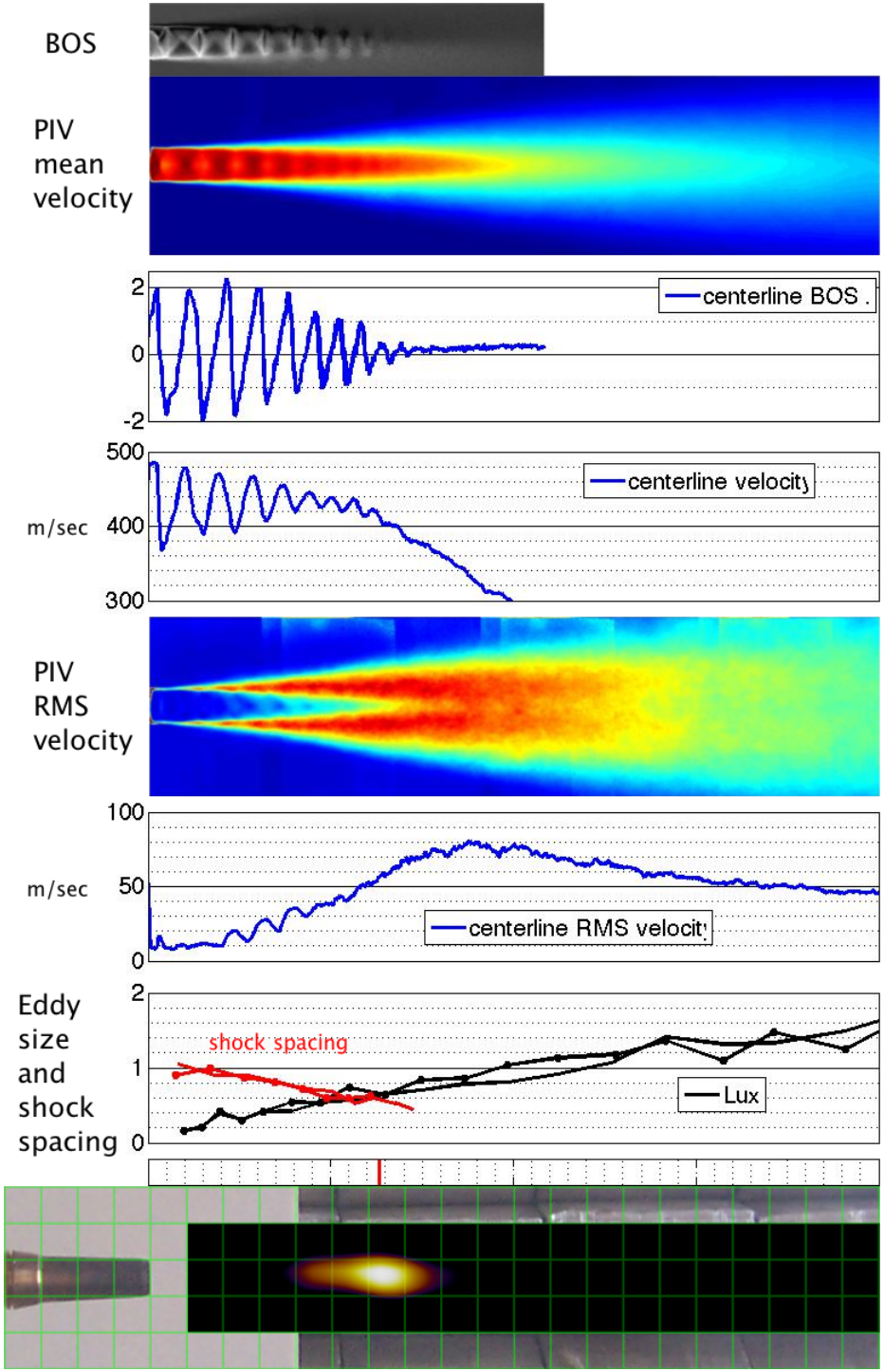

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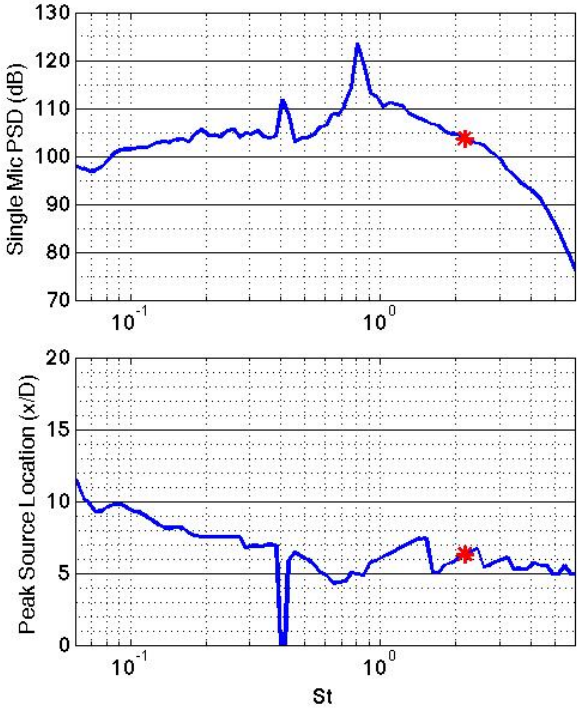

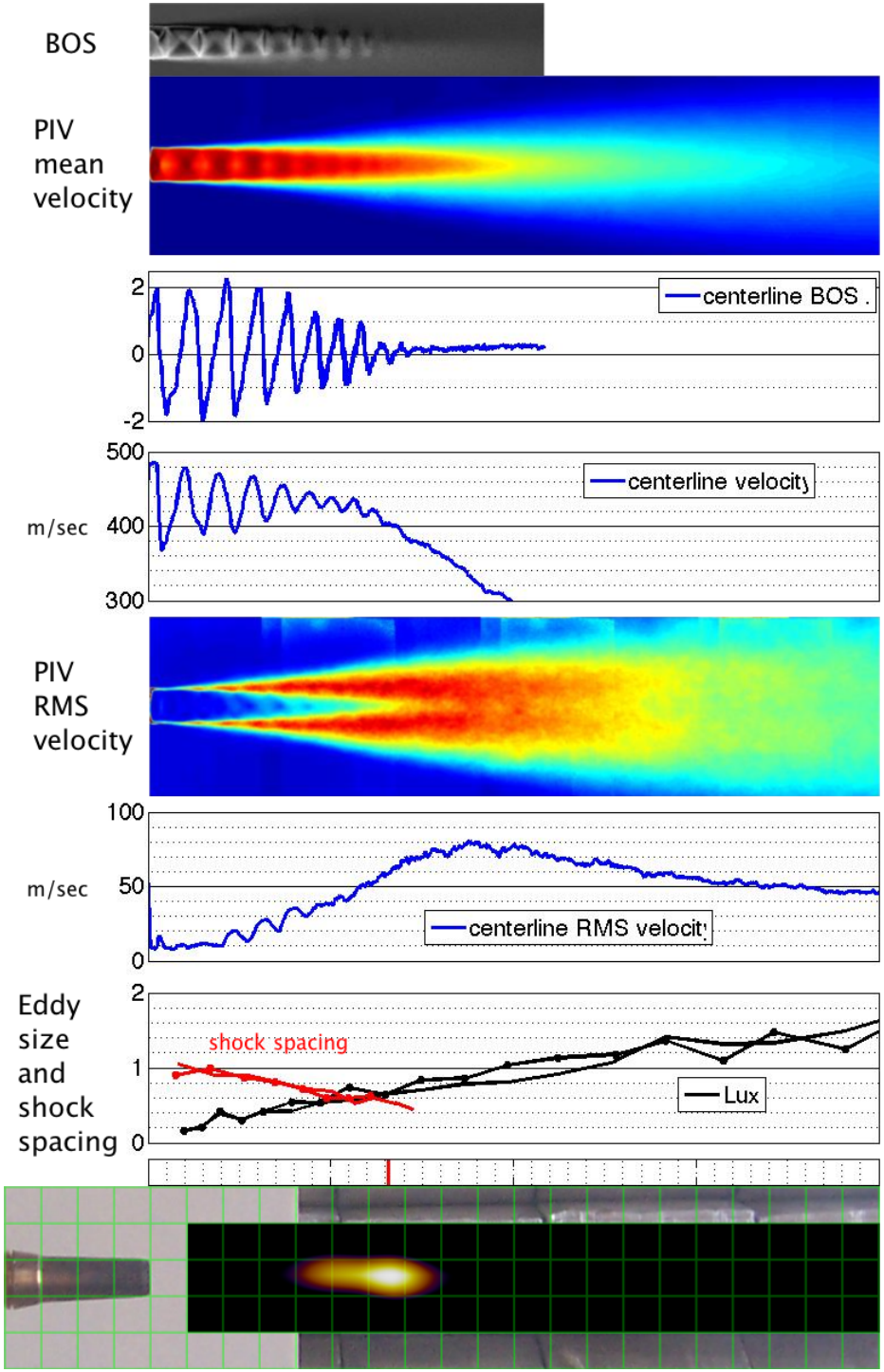

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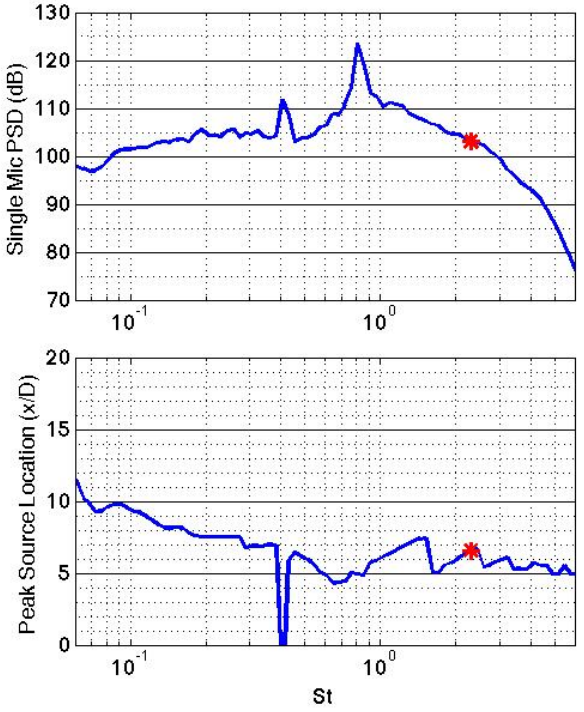

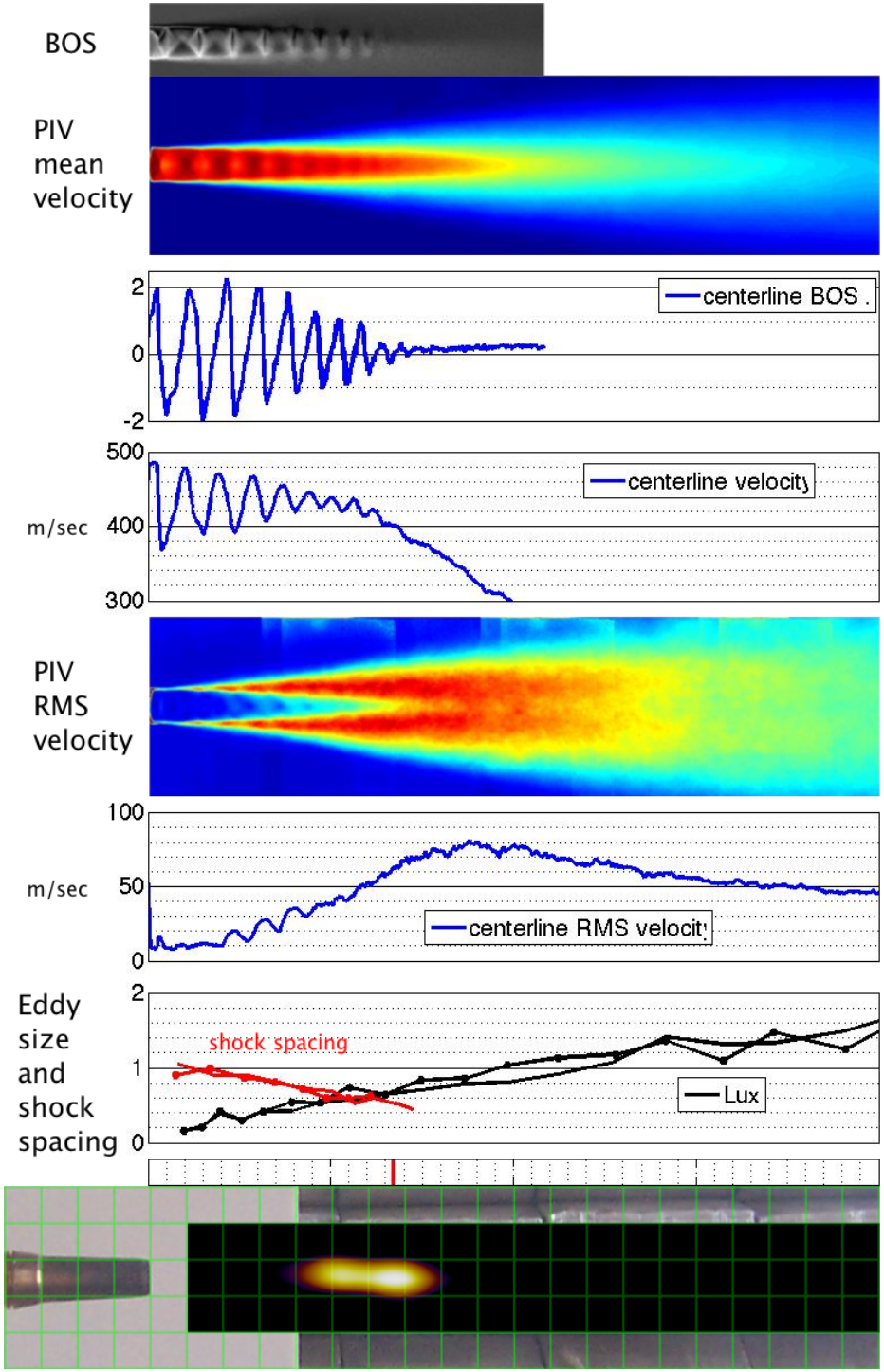

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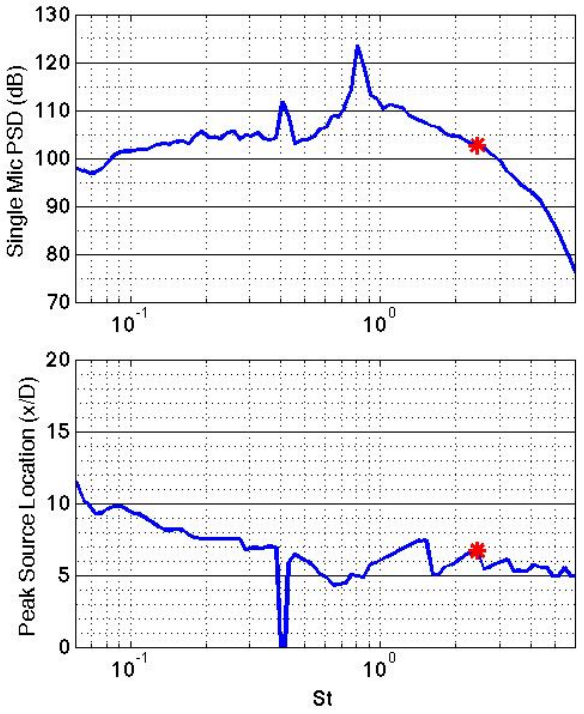

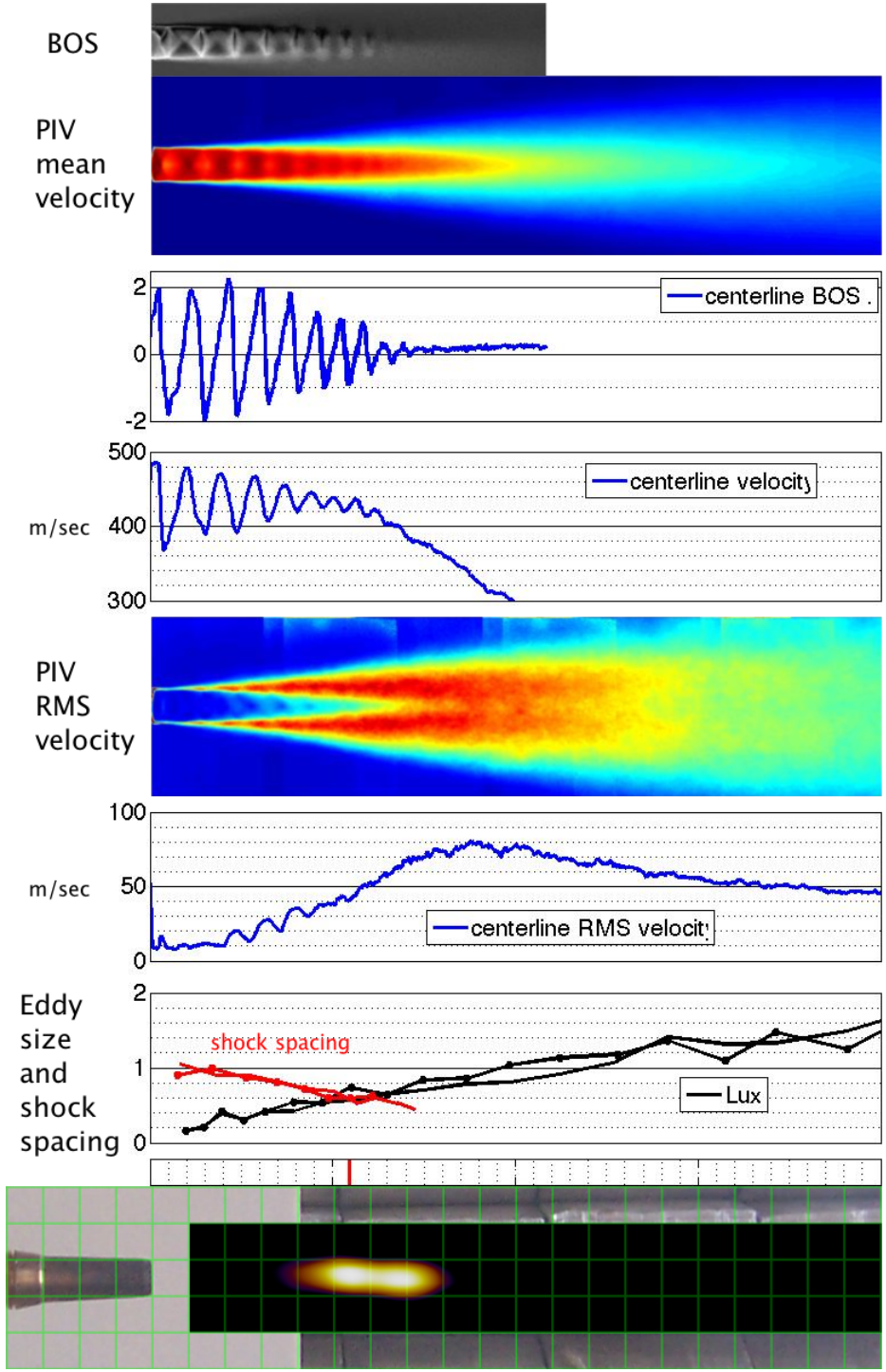

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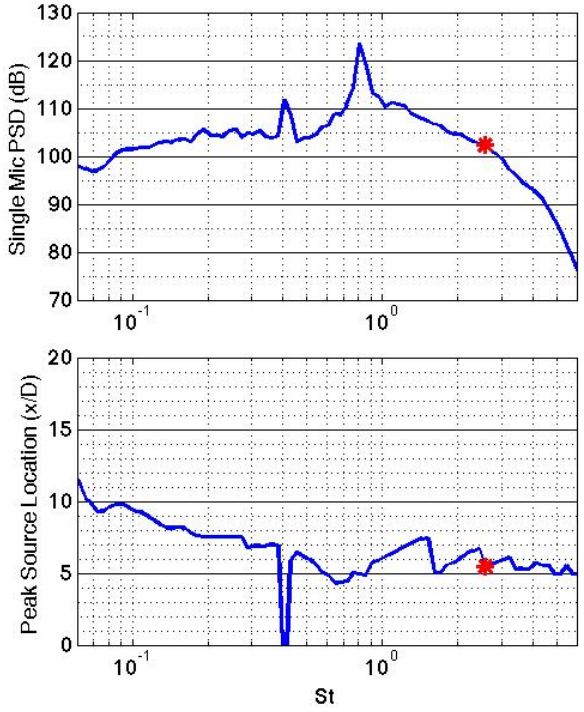

SMC016 convergent-divergent

ideally-expanded

set point 11610

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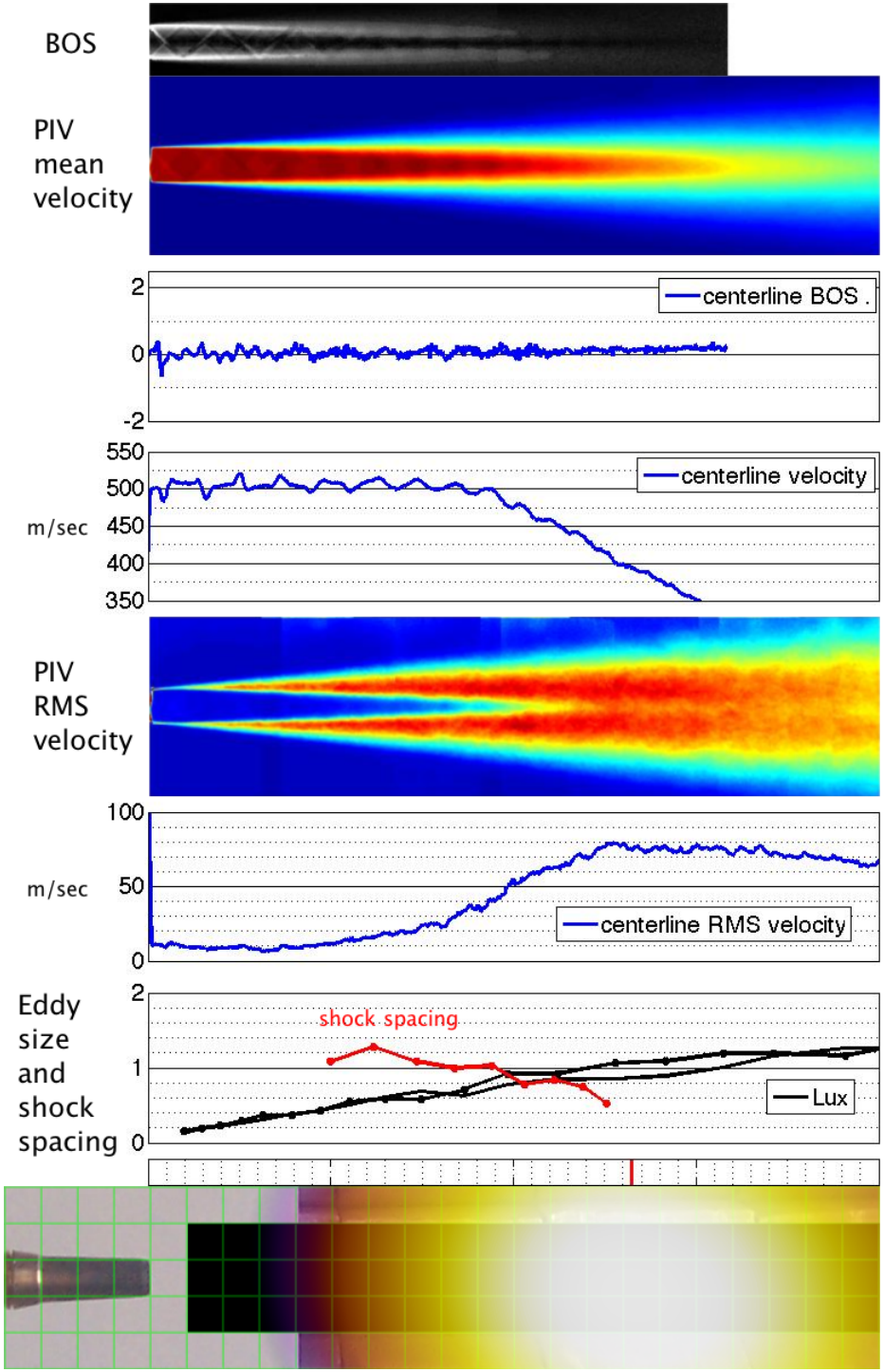

SMC016

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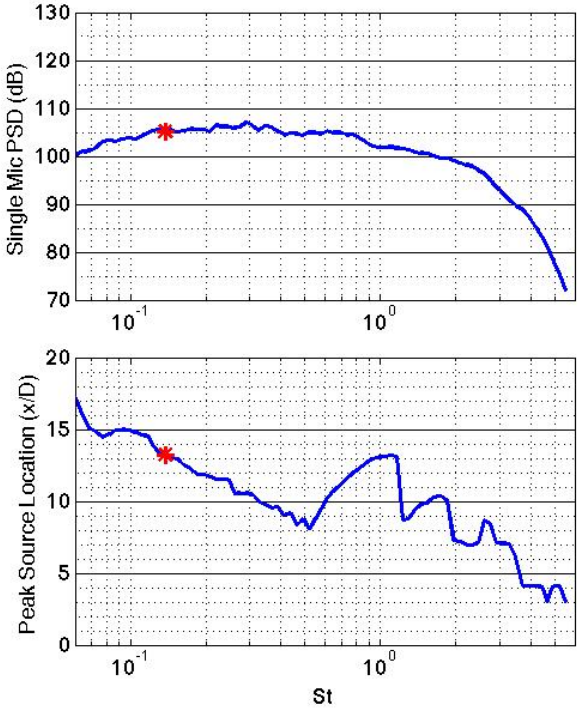

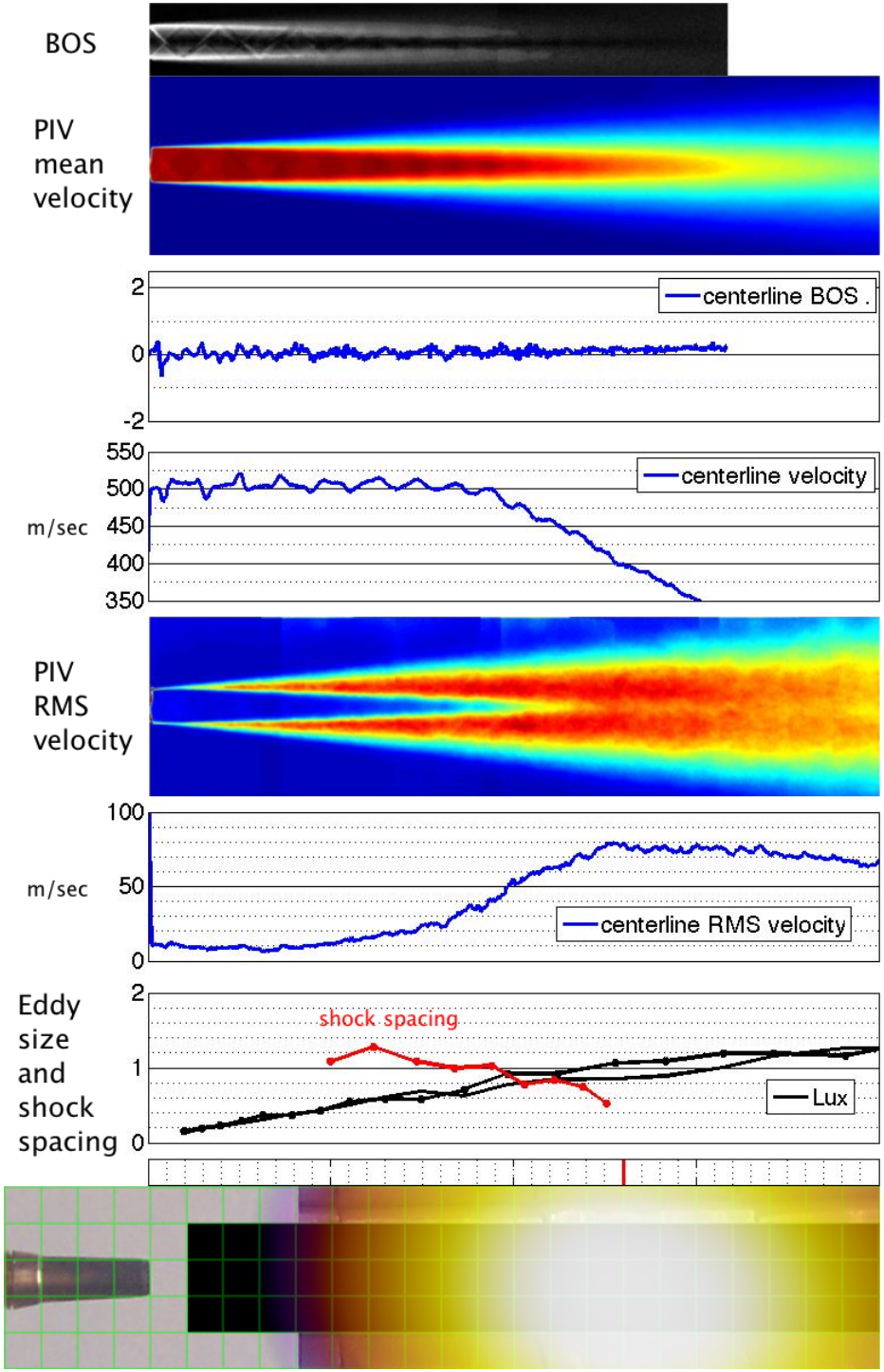

SMC016

ideally-expanded

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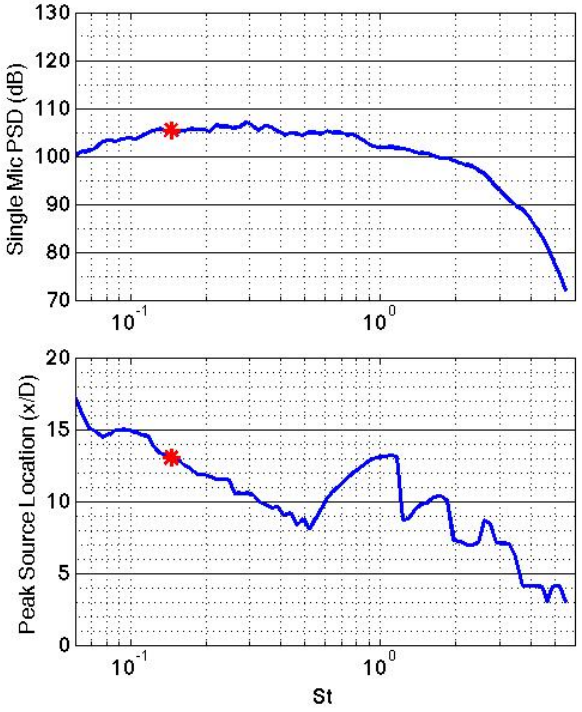

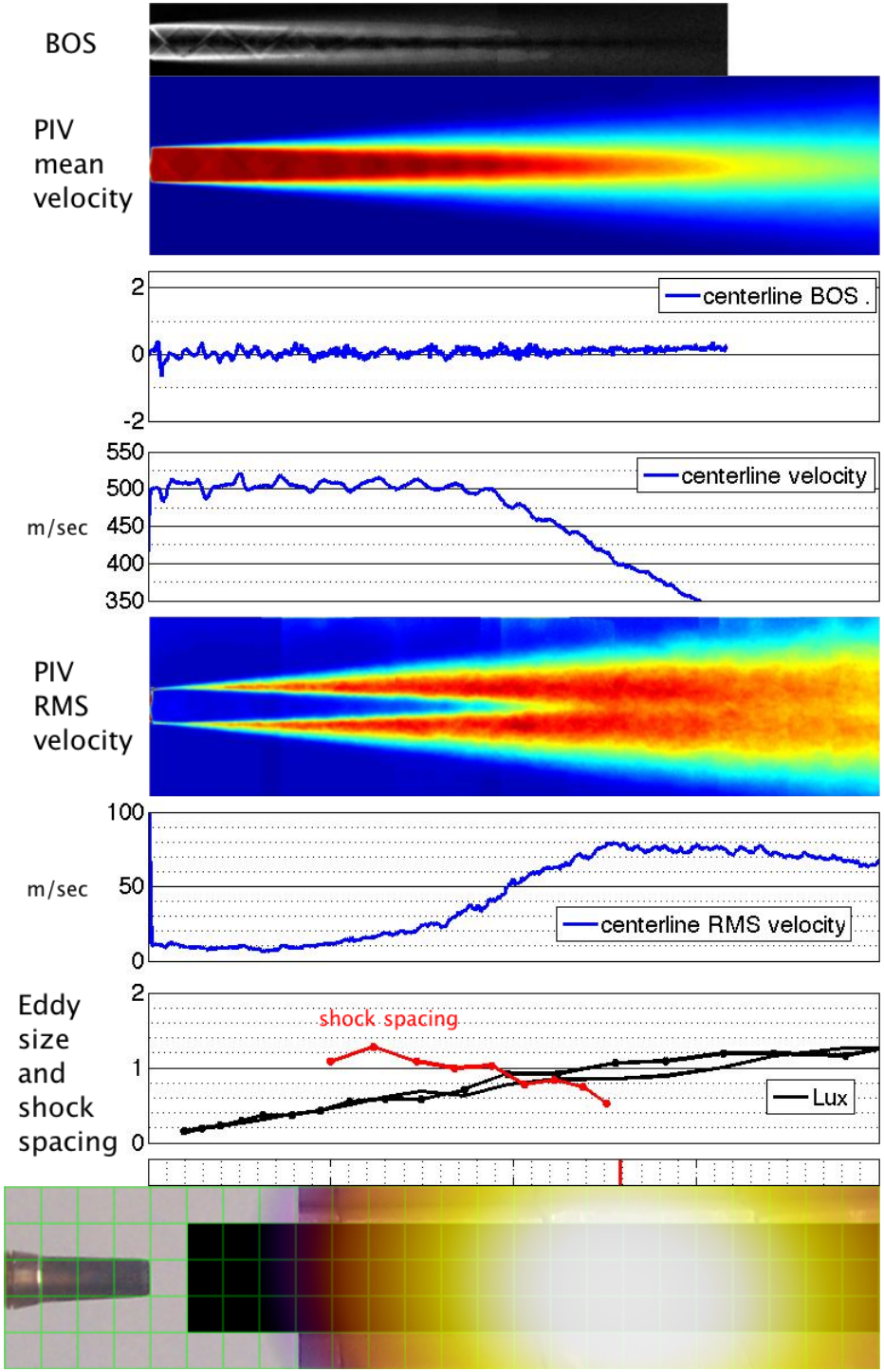

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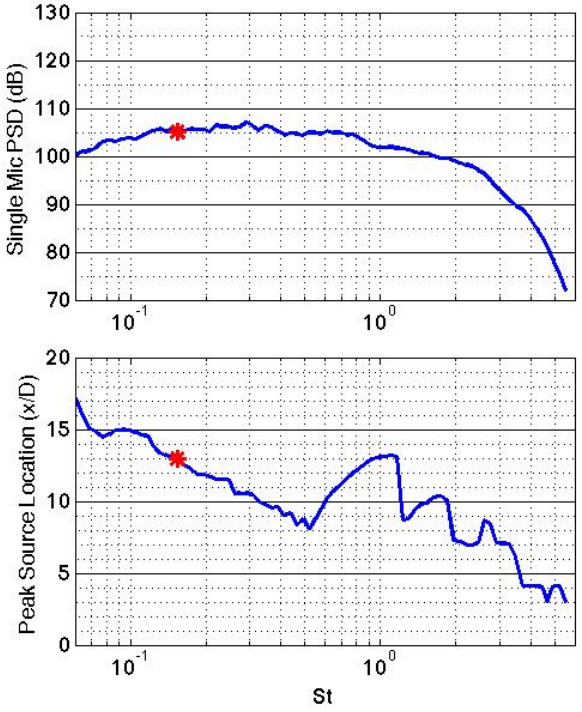

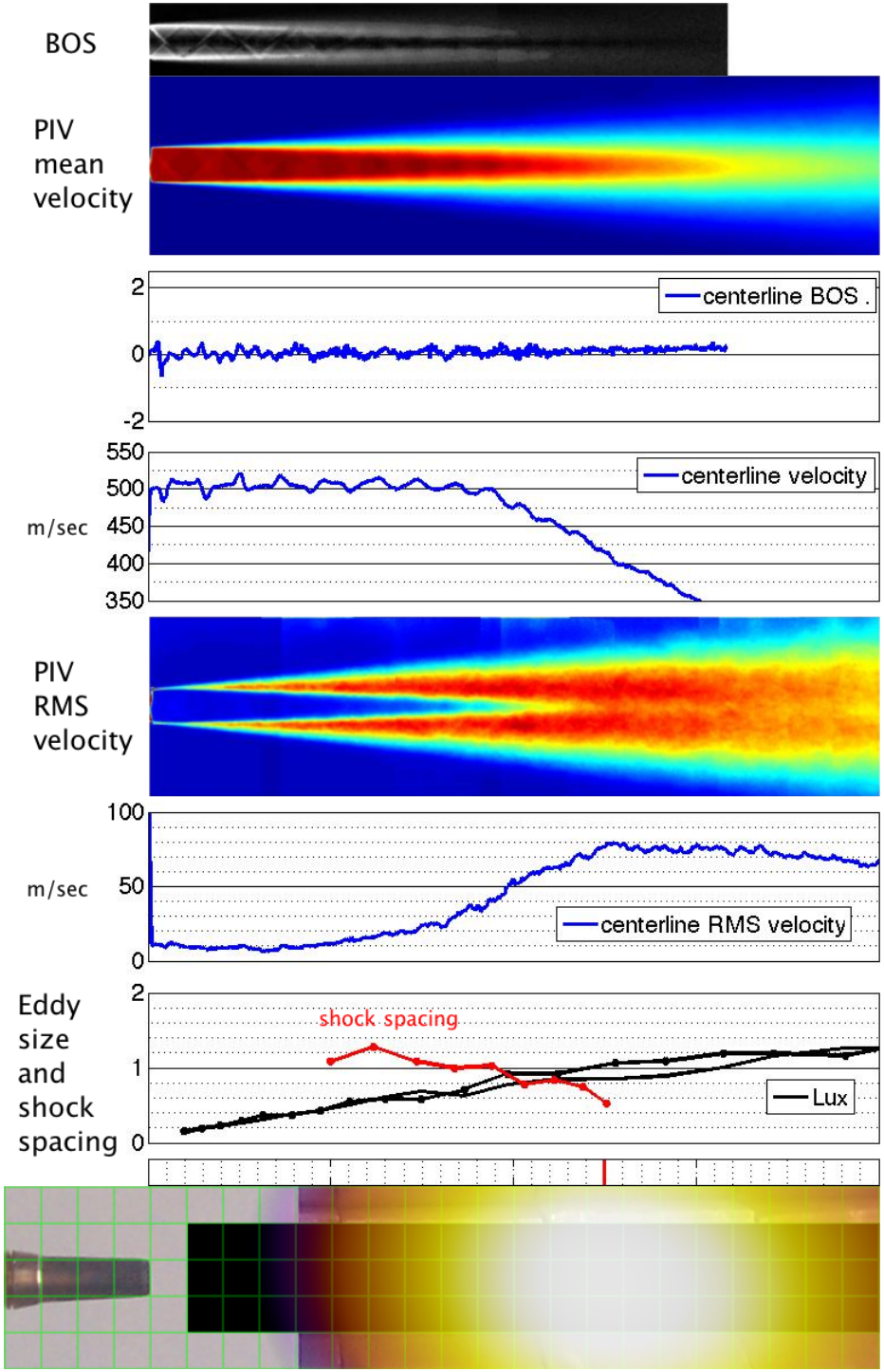

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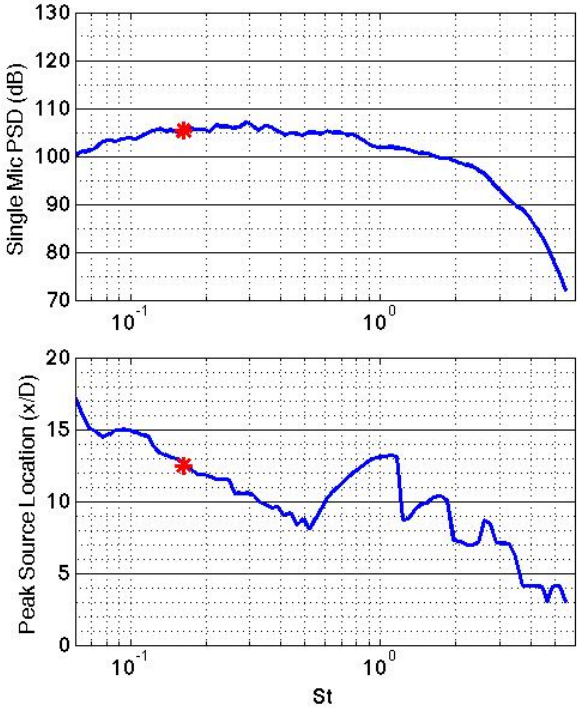

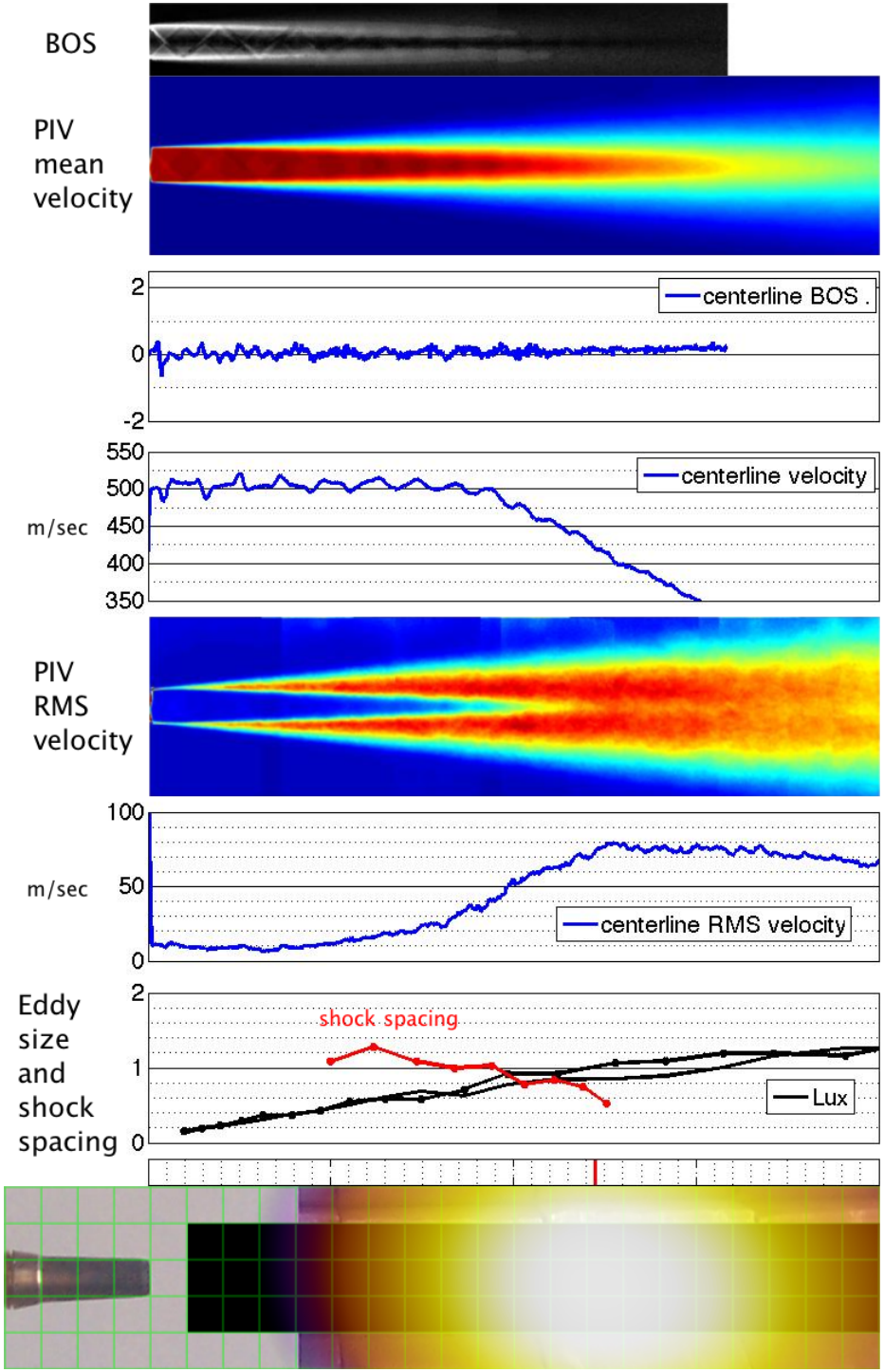

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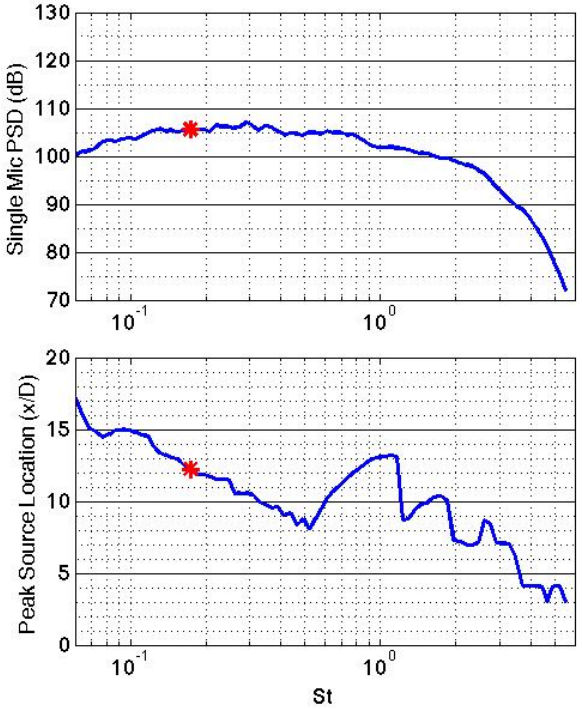

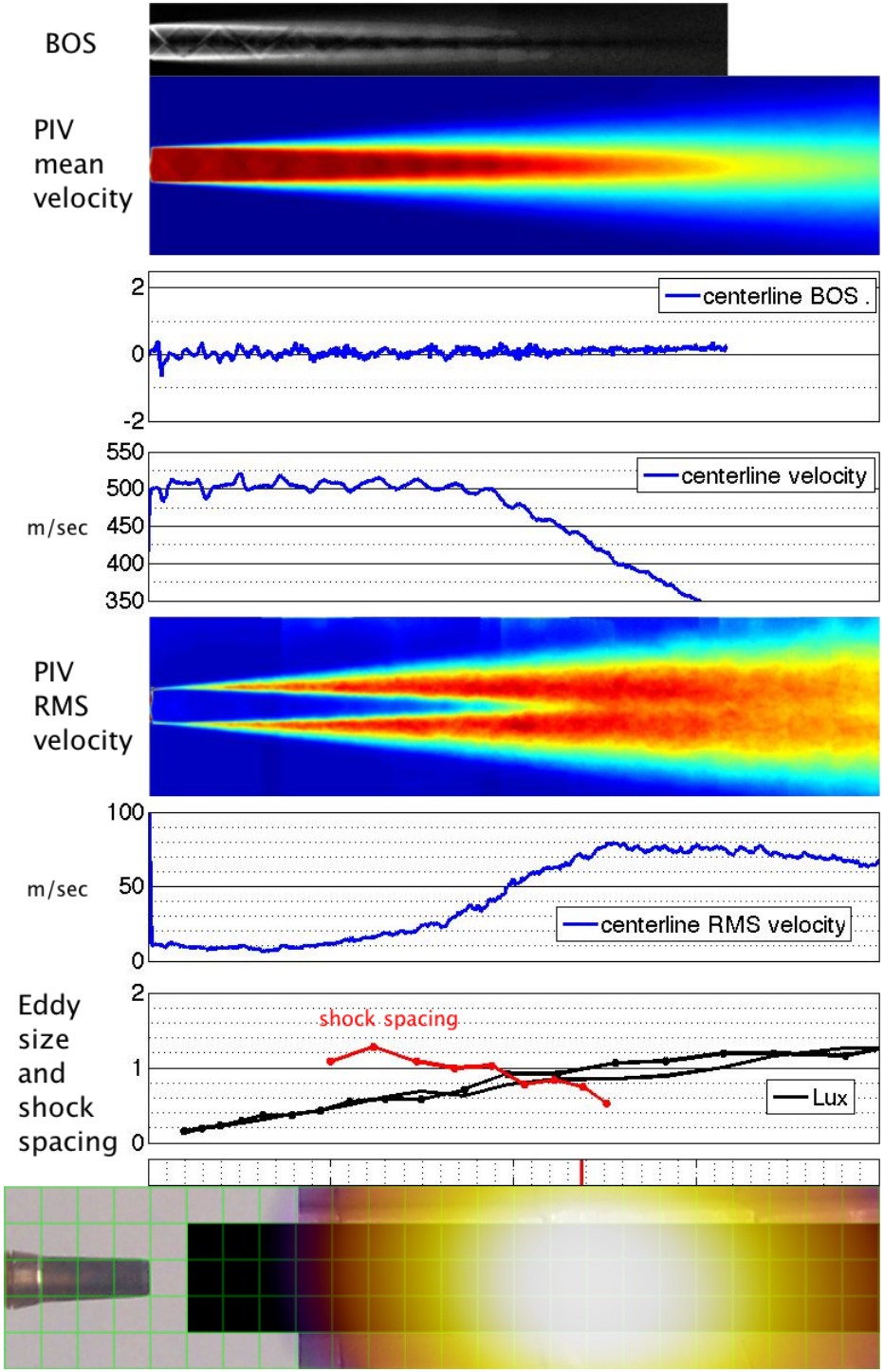

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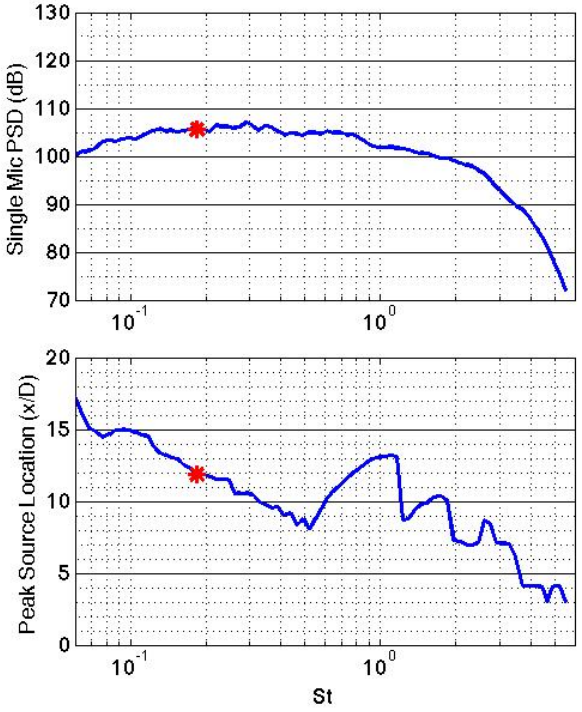

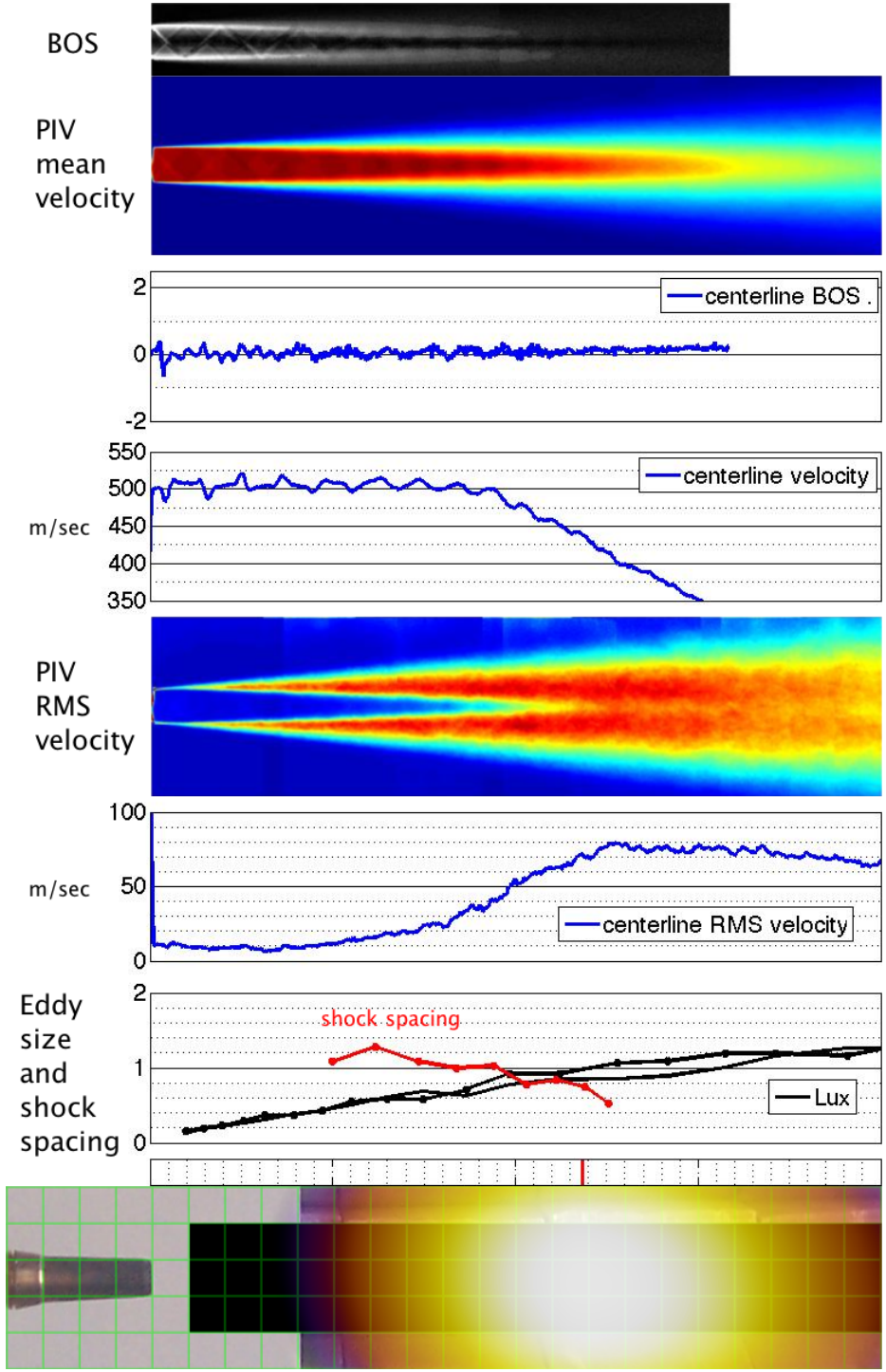

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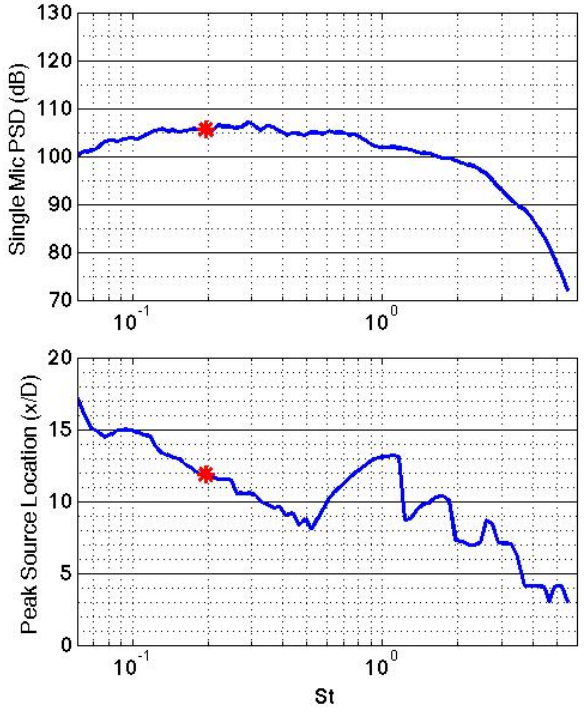

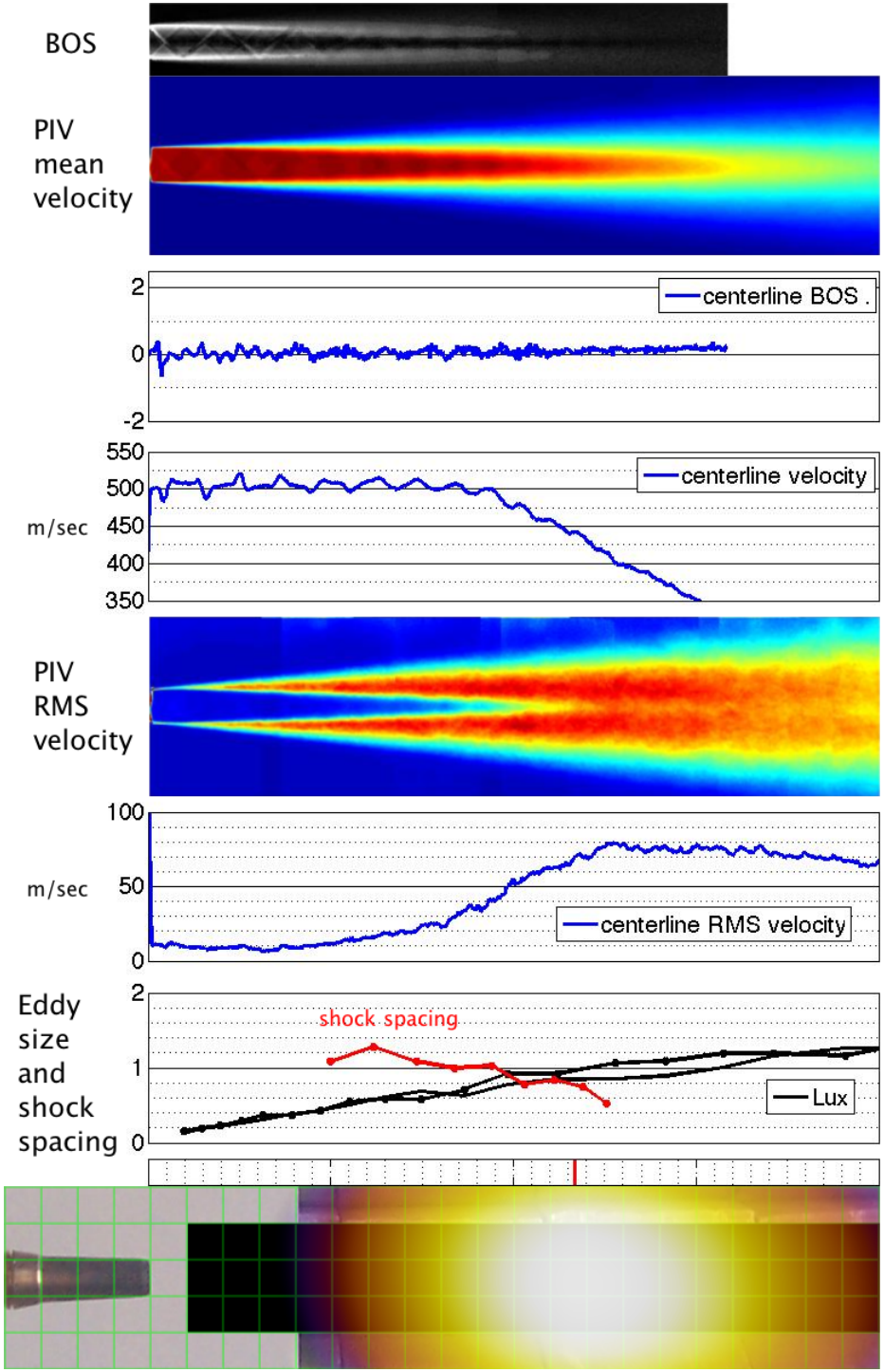

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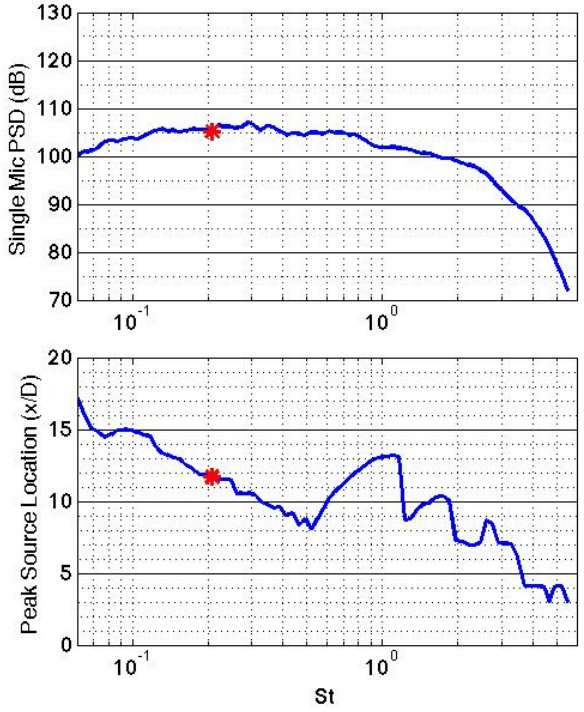

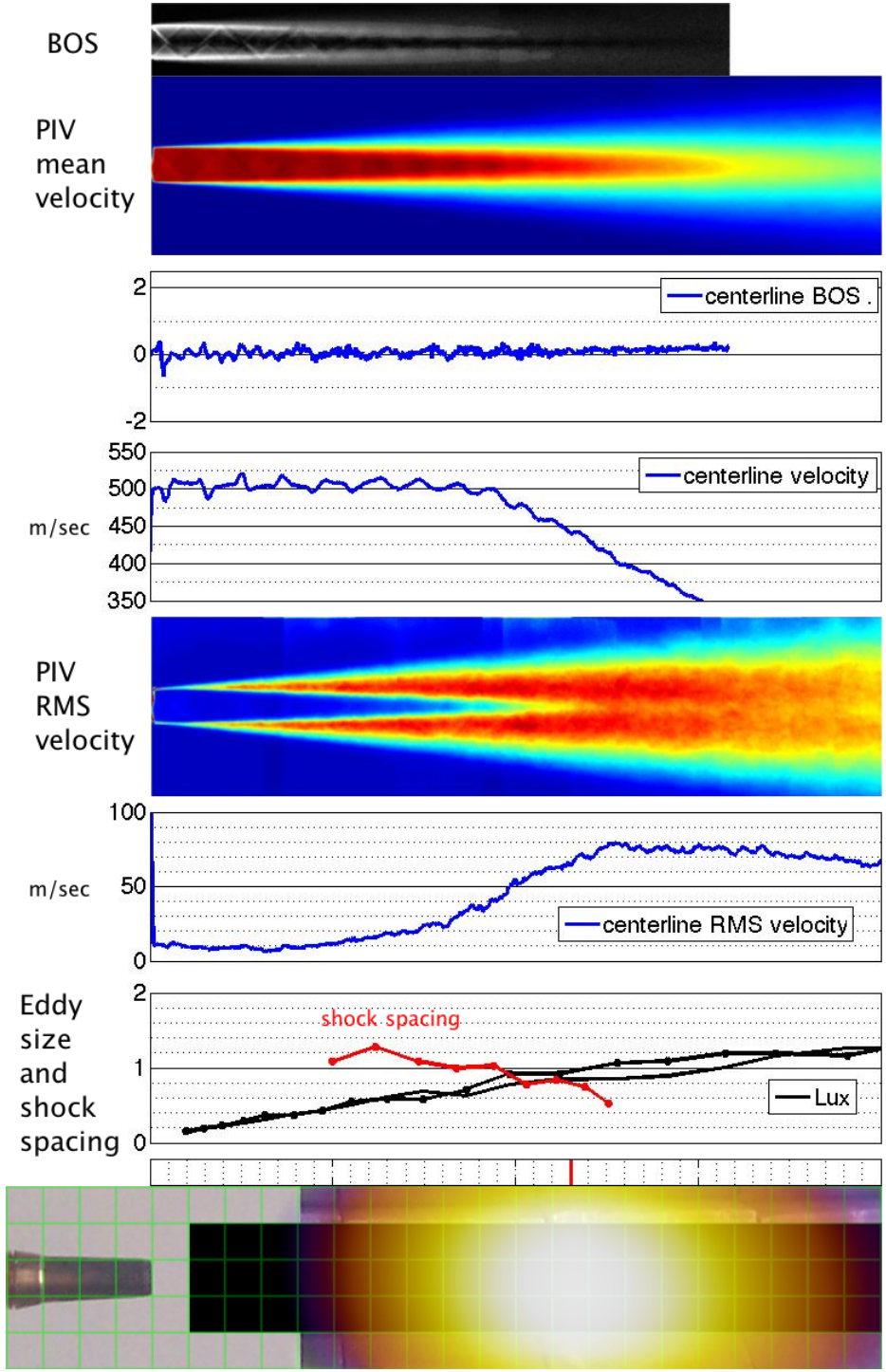

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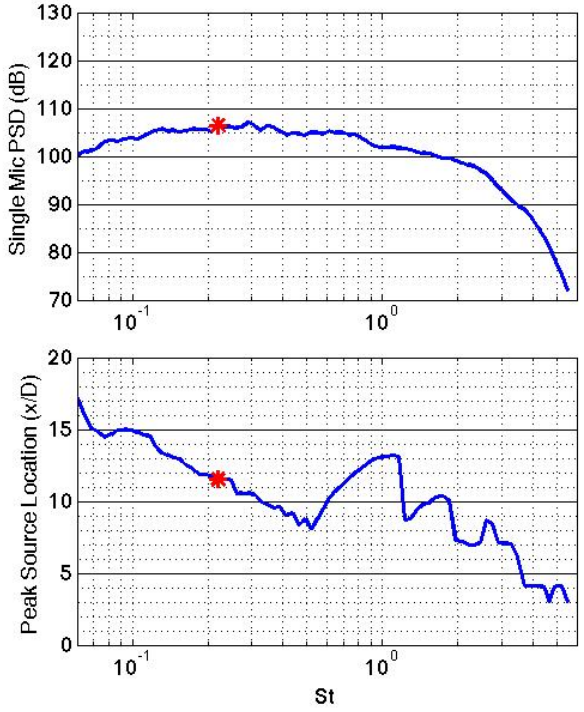

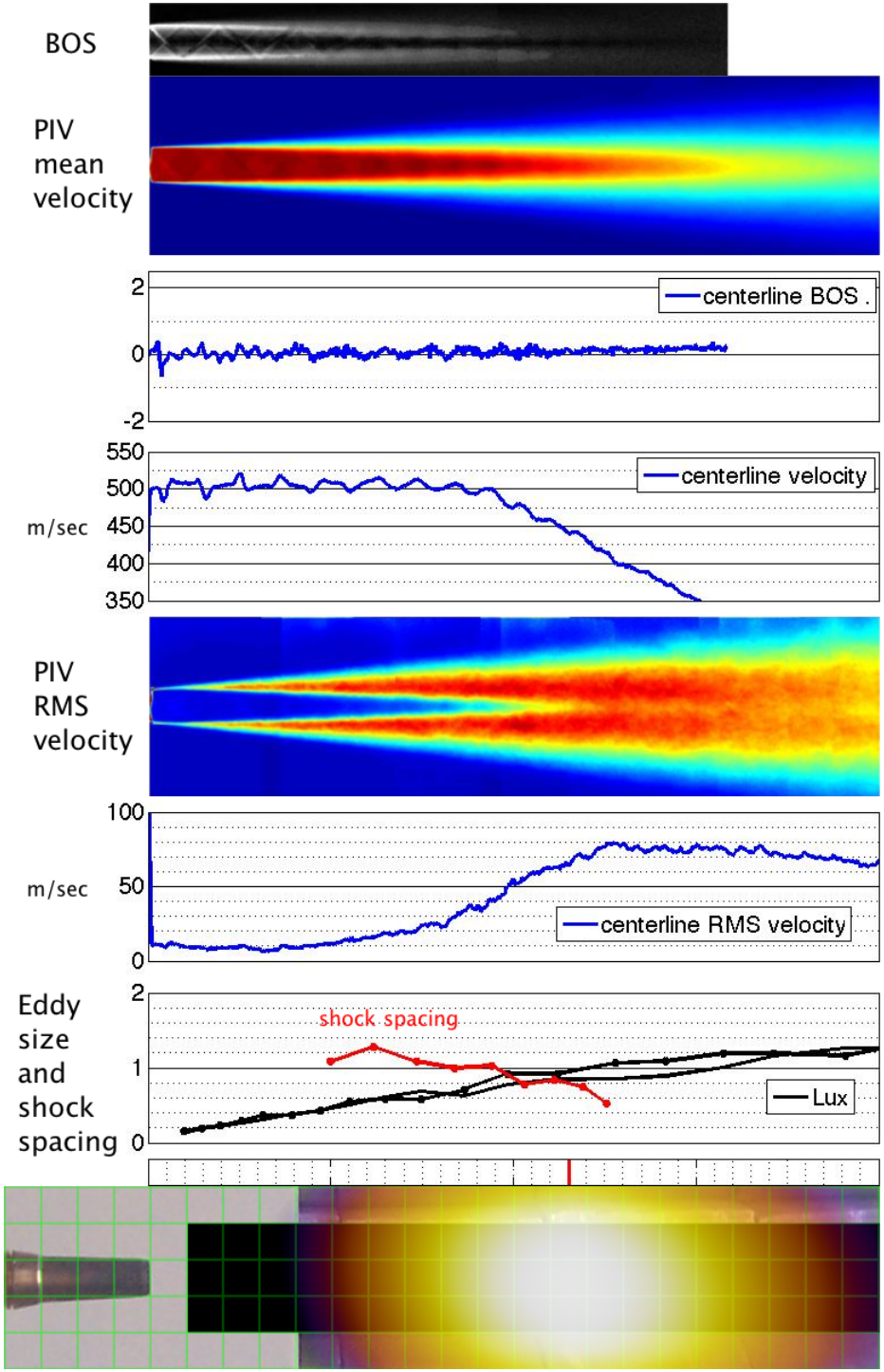

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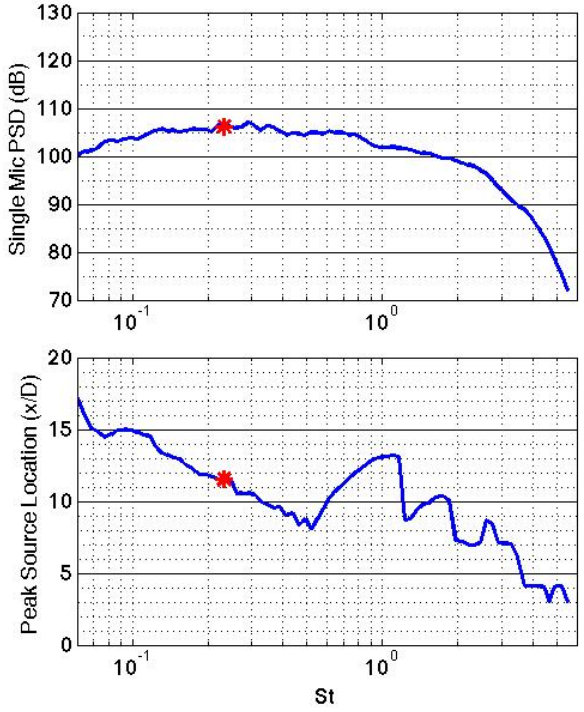

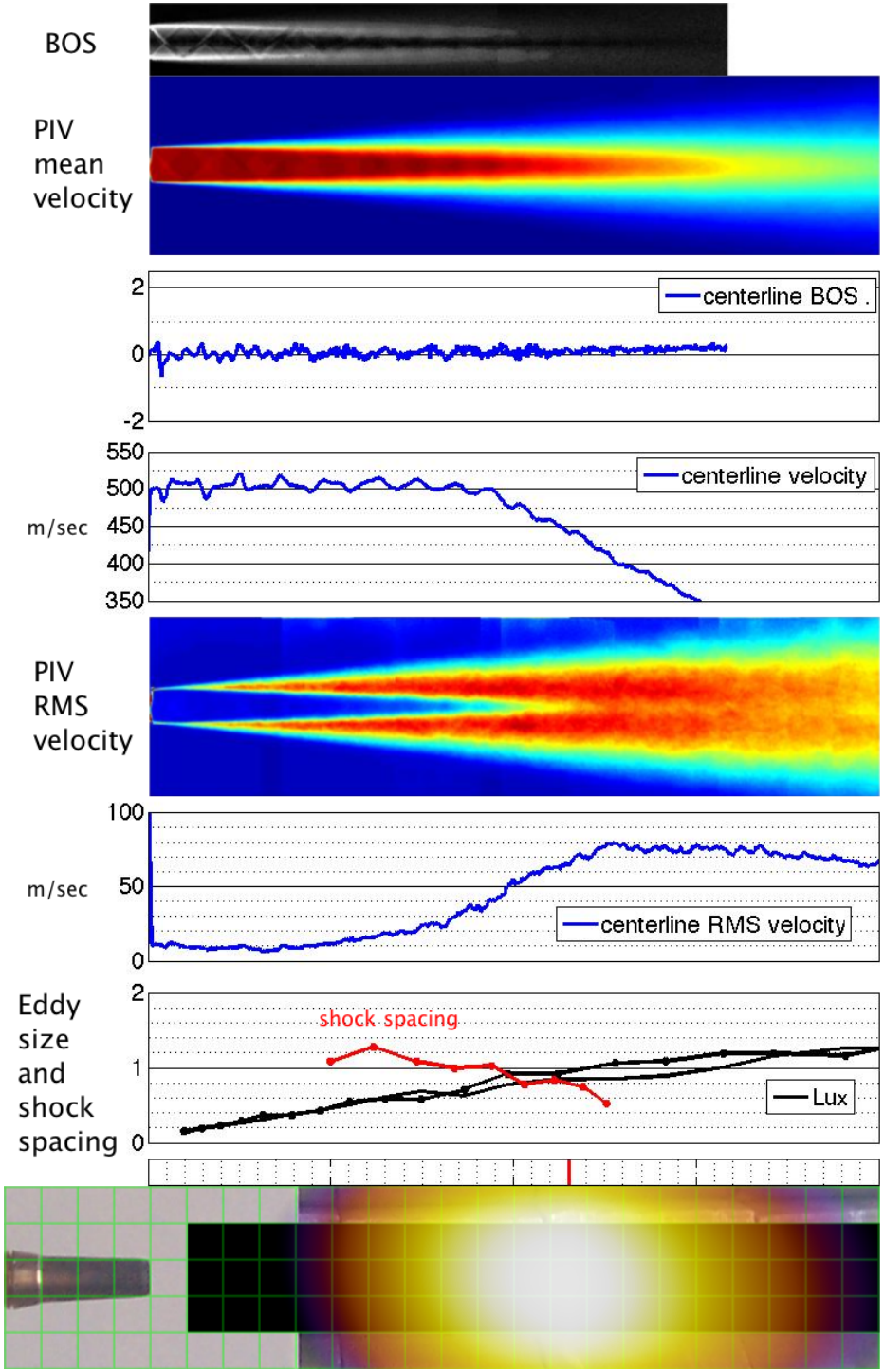

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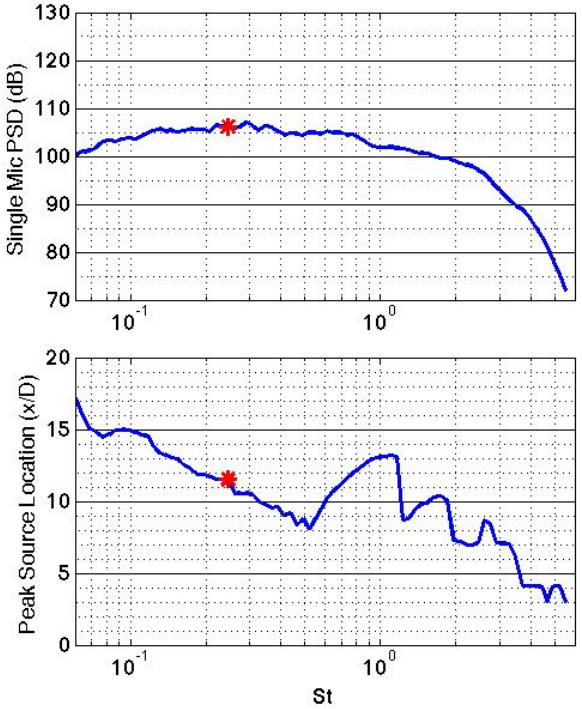

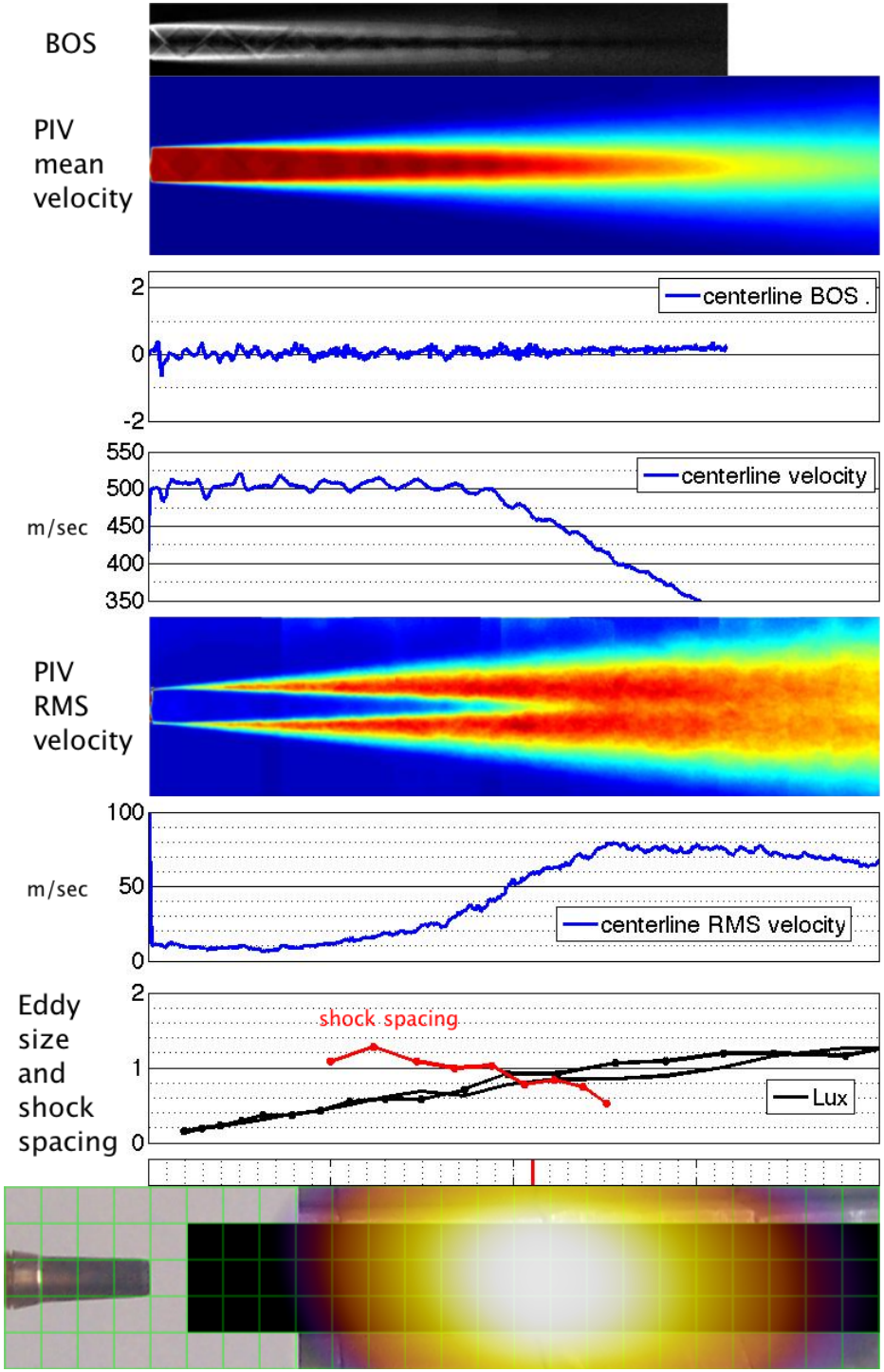

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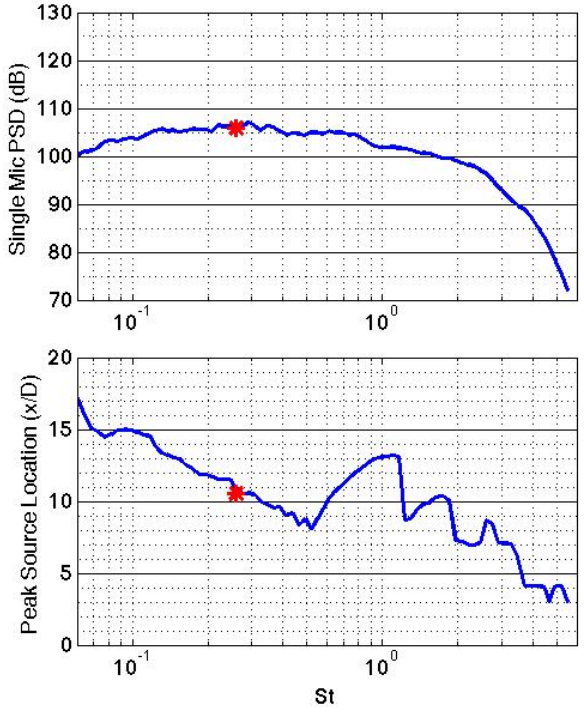

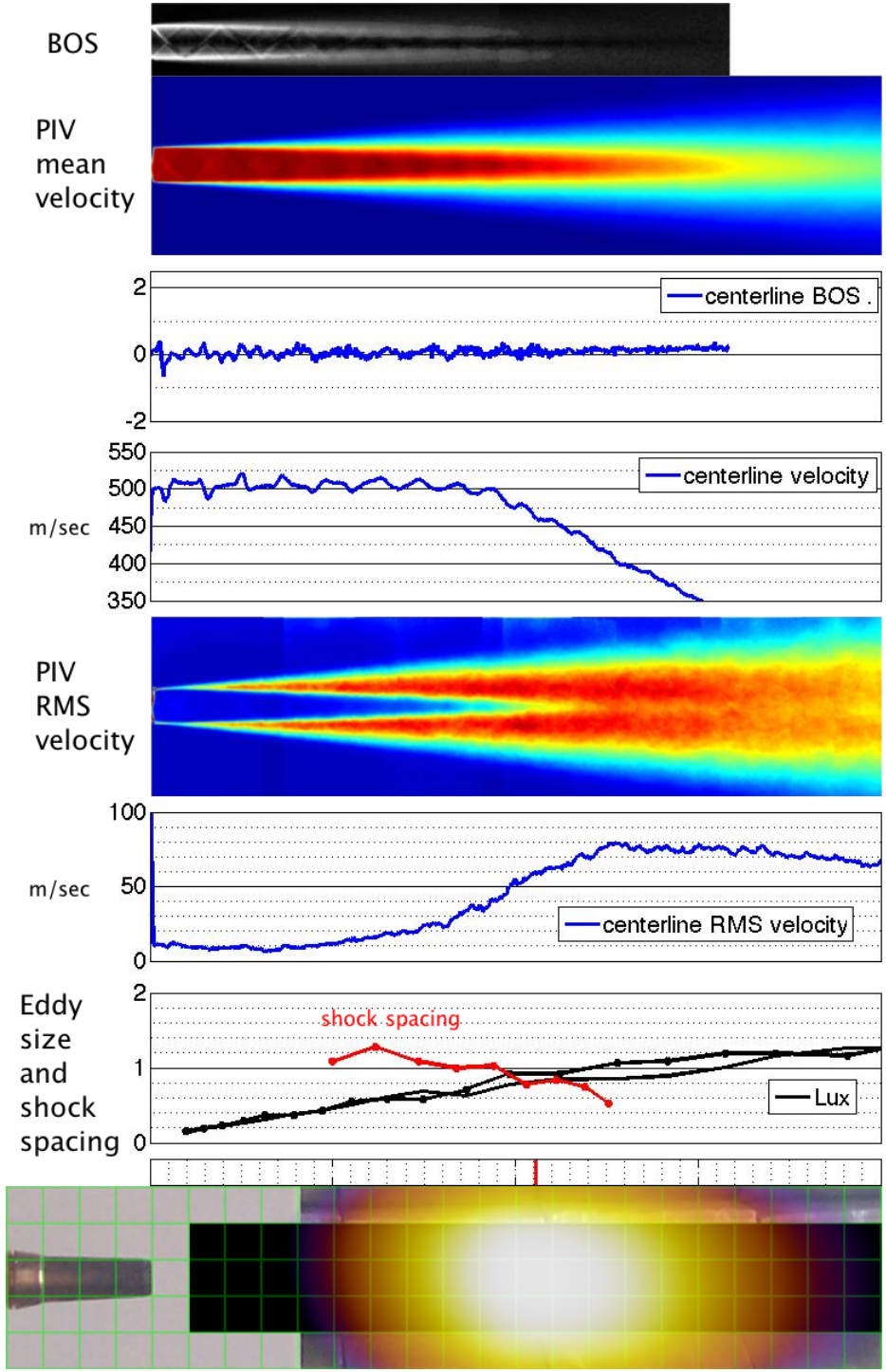

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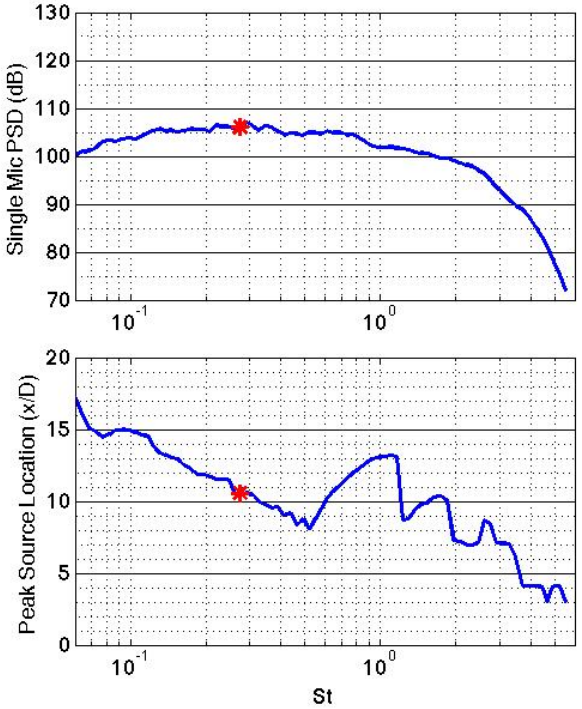

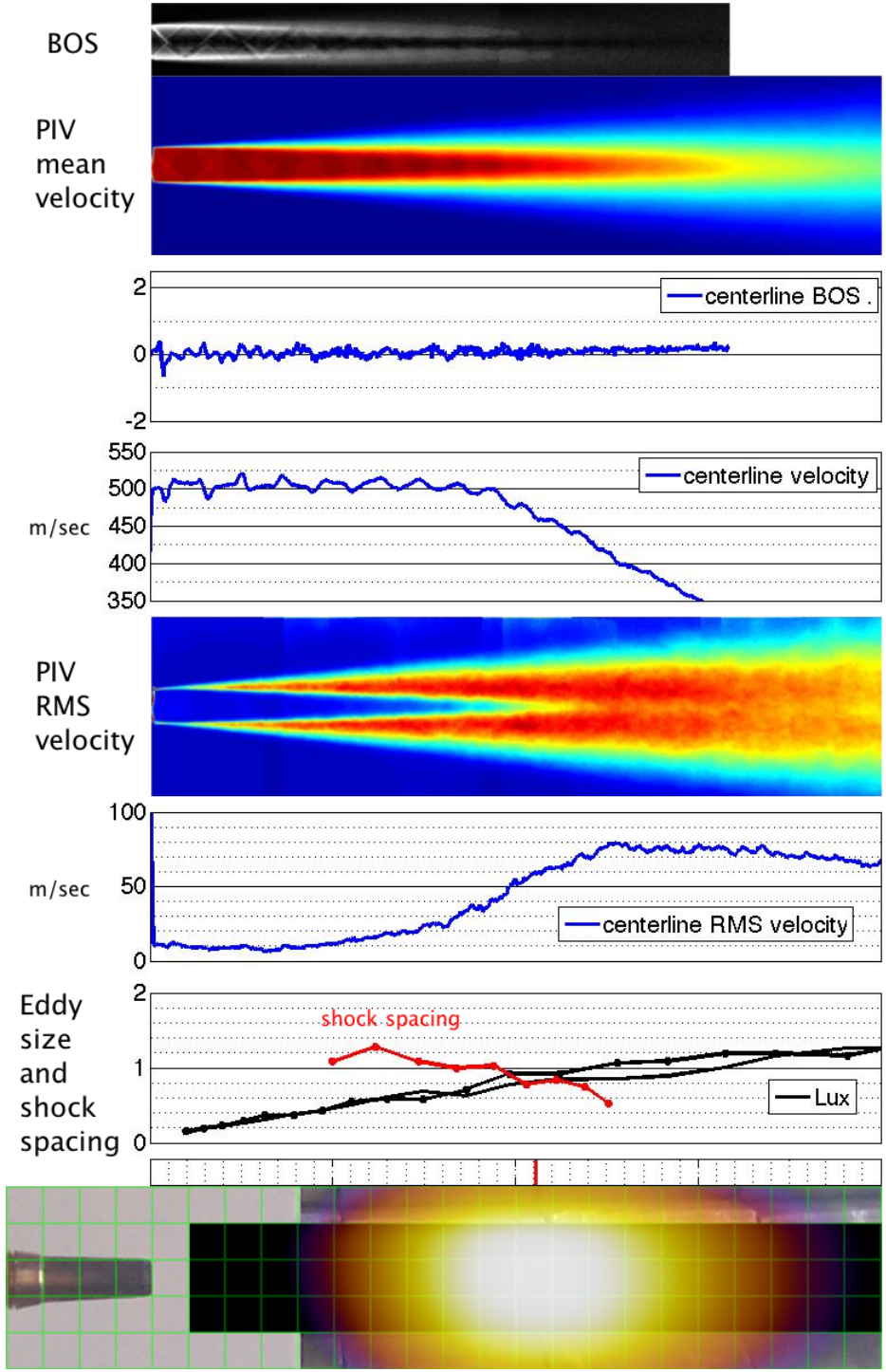

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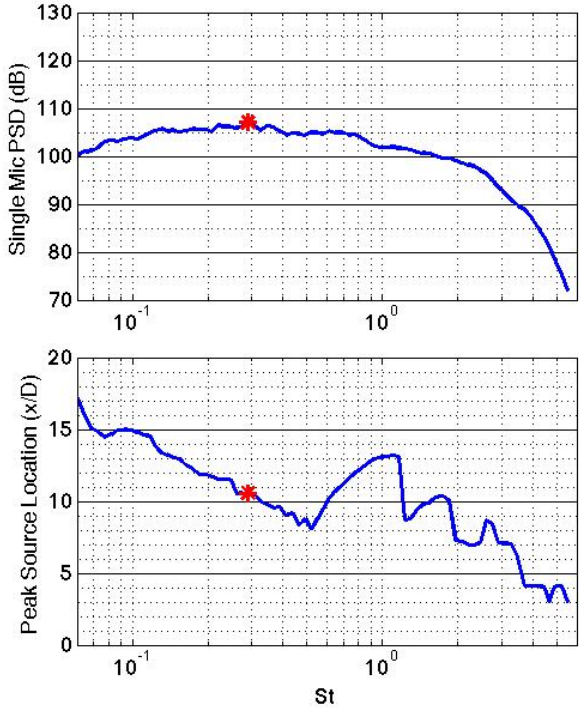

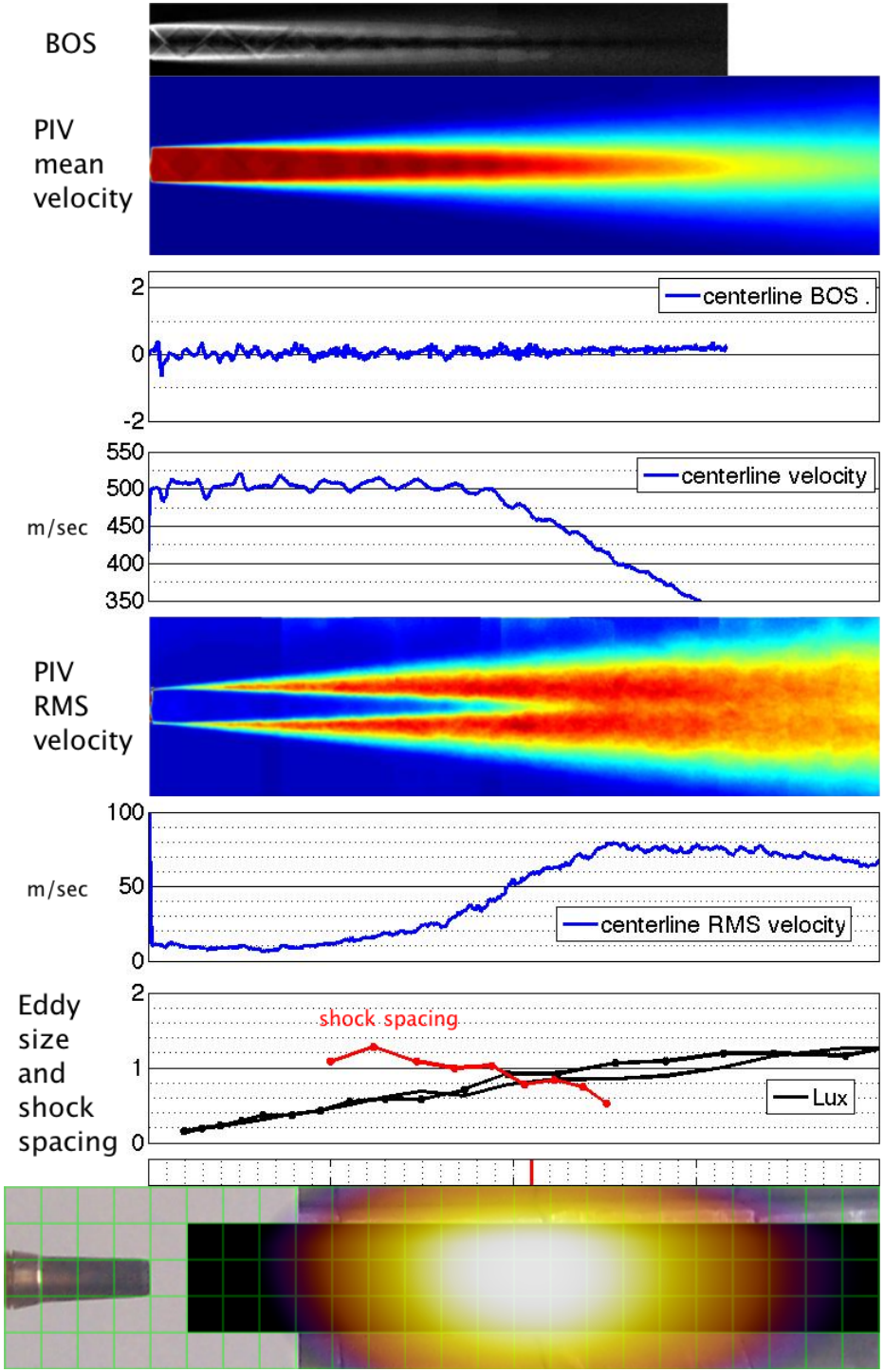

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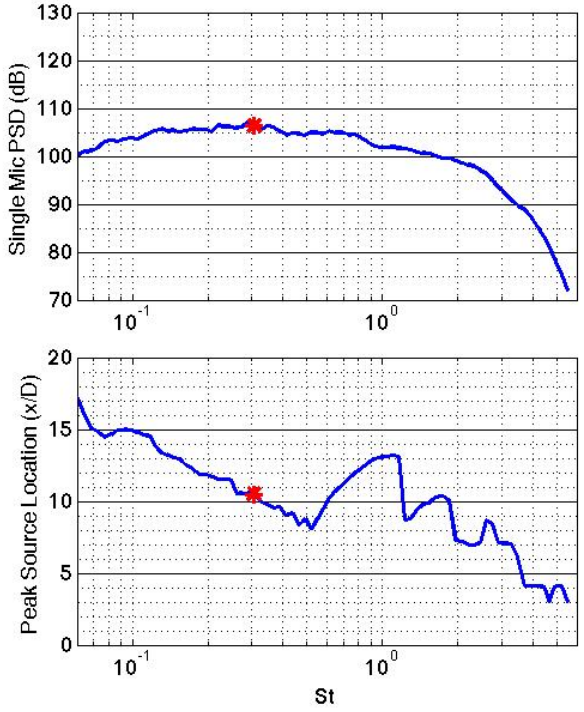

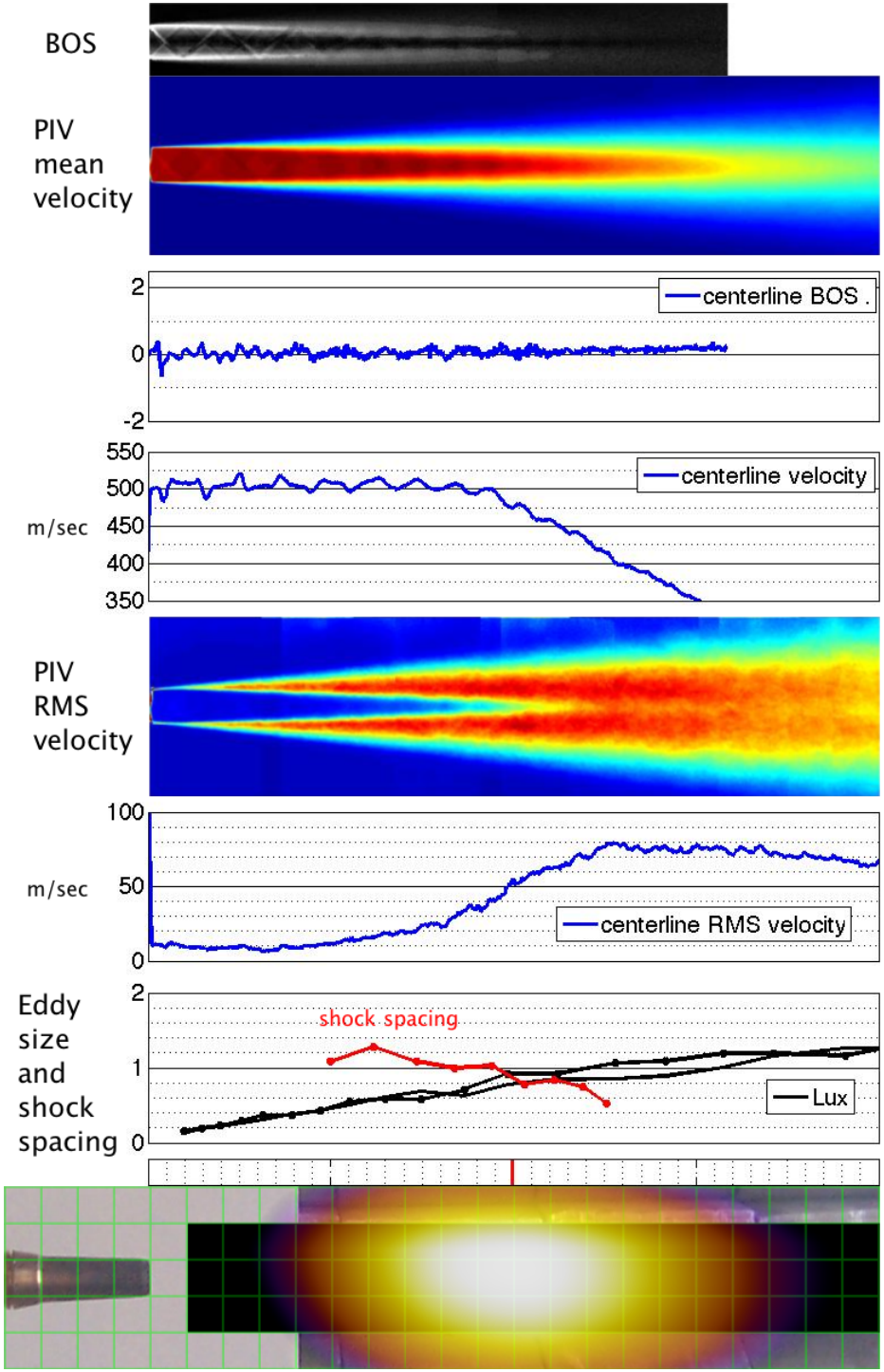

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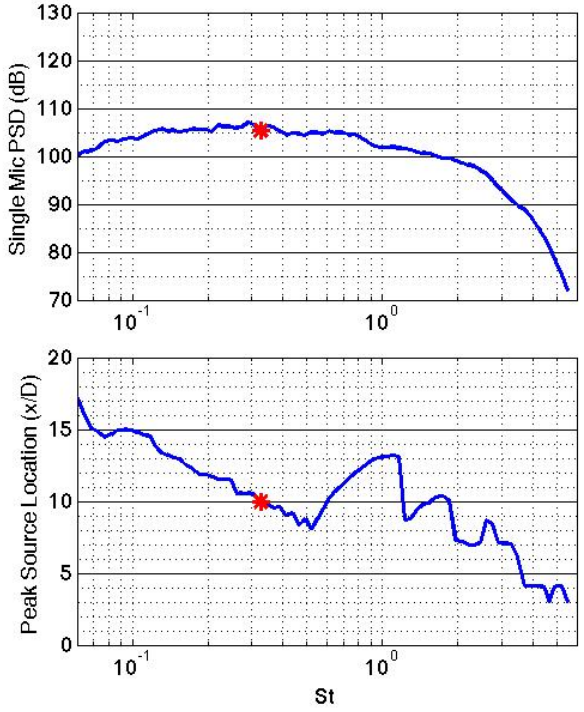

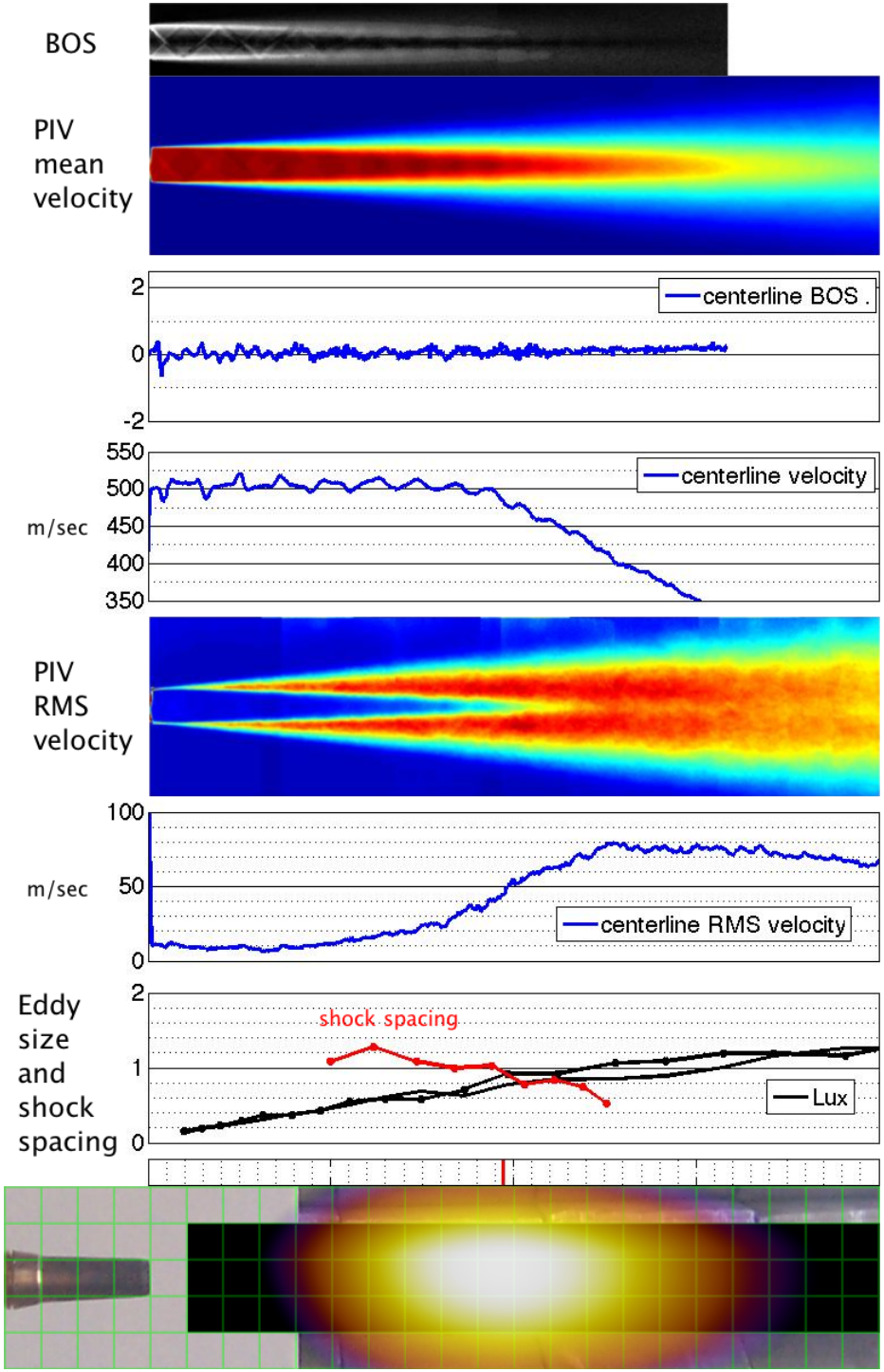

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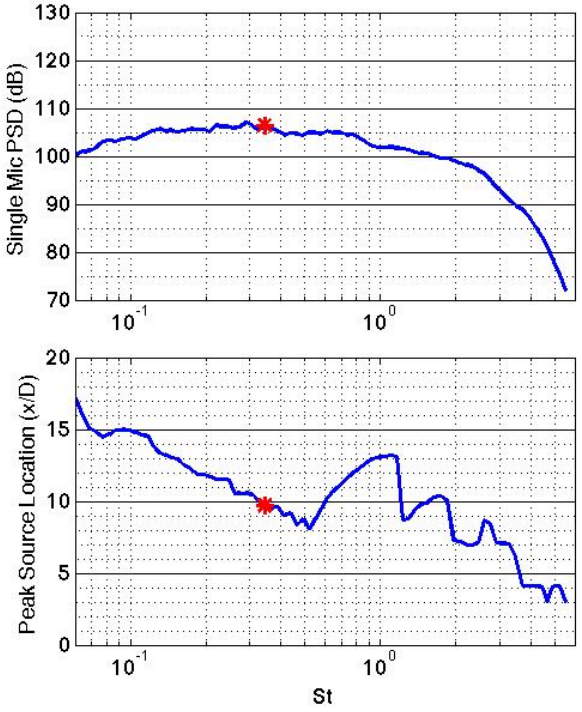

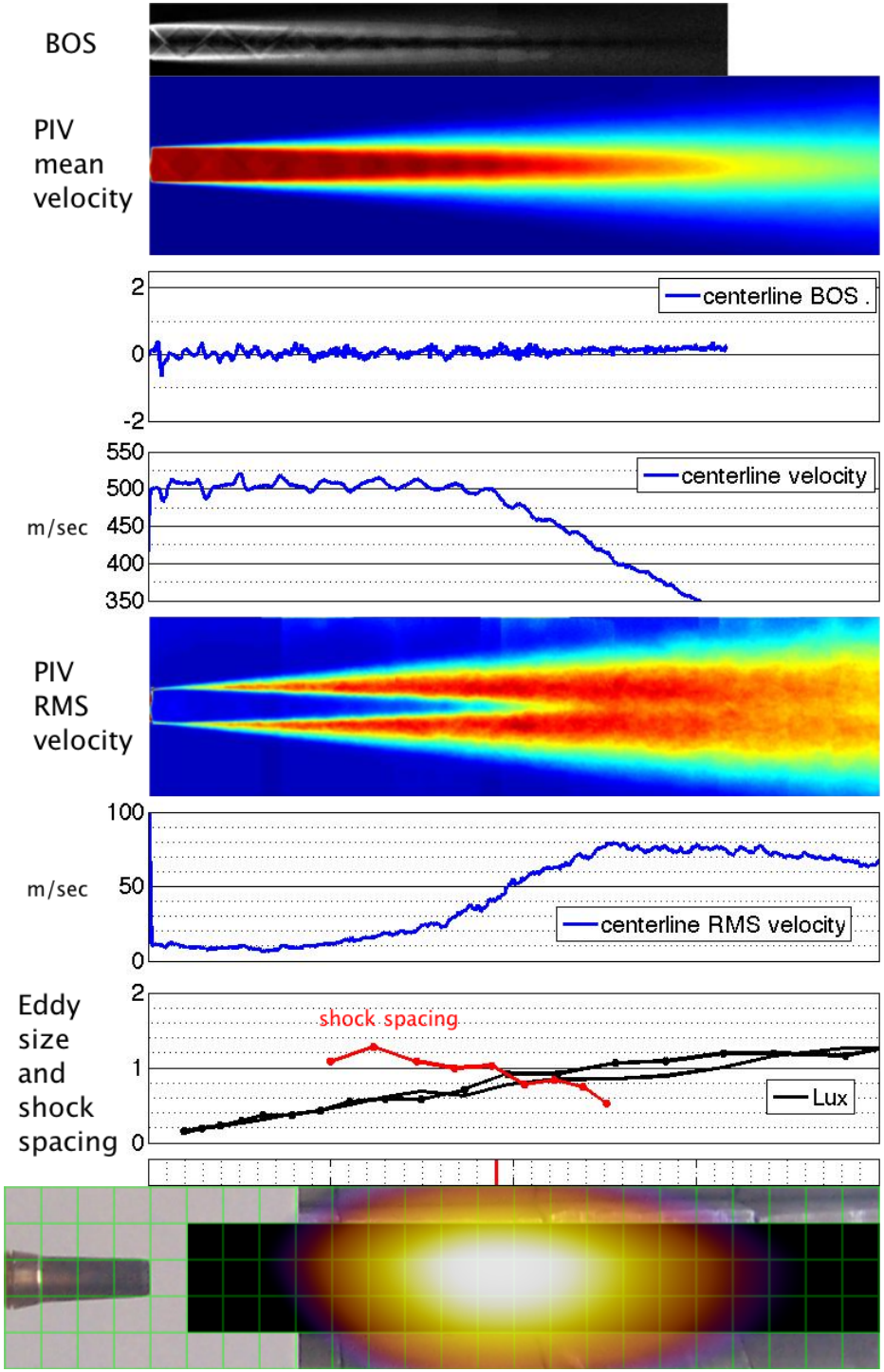

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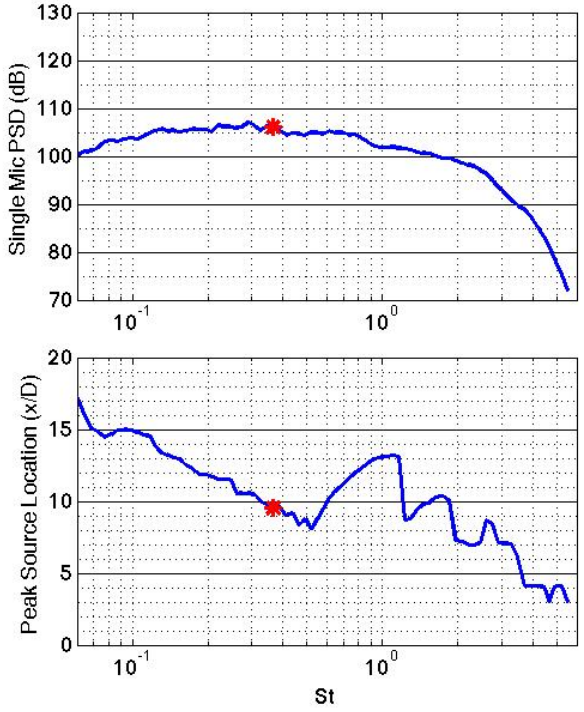

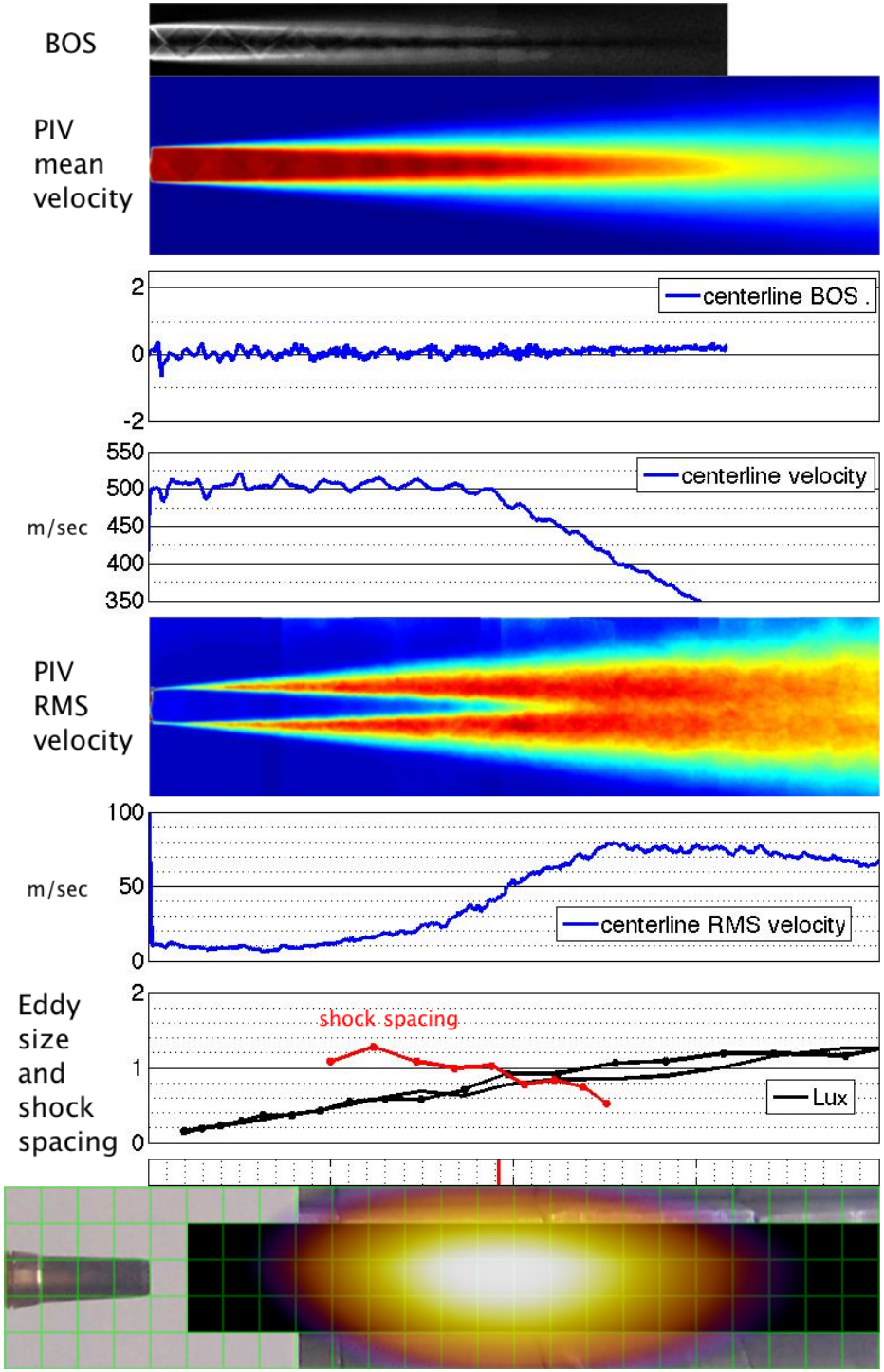

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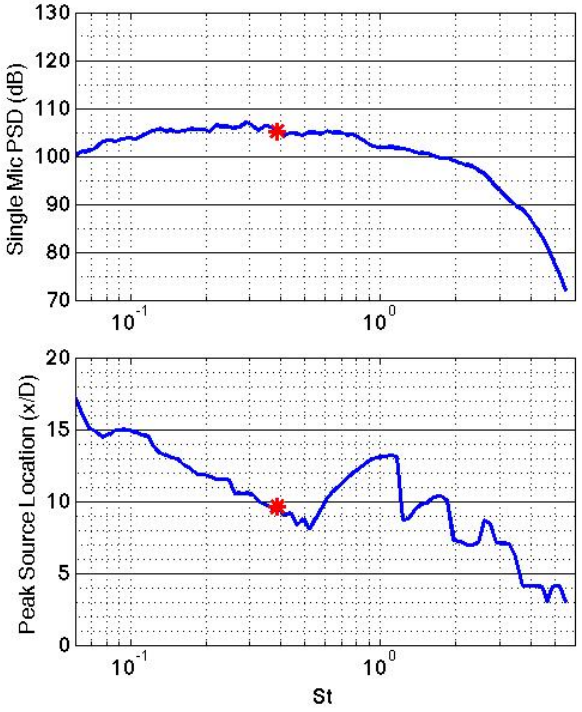

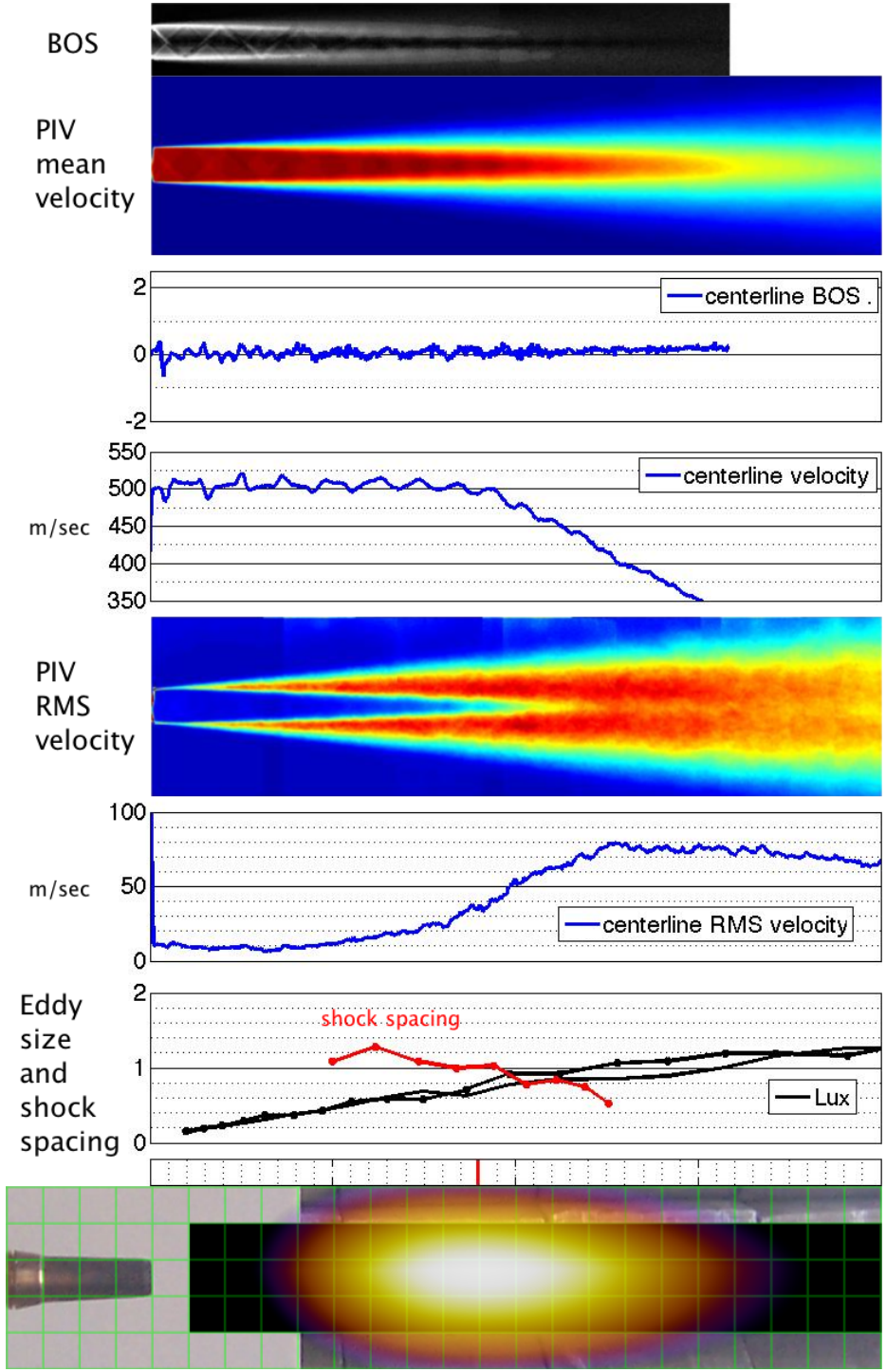

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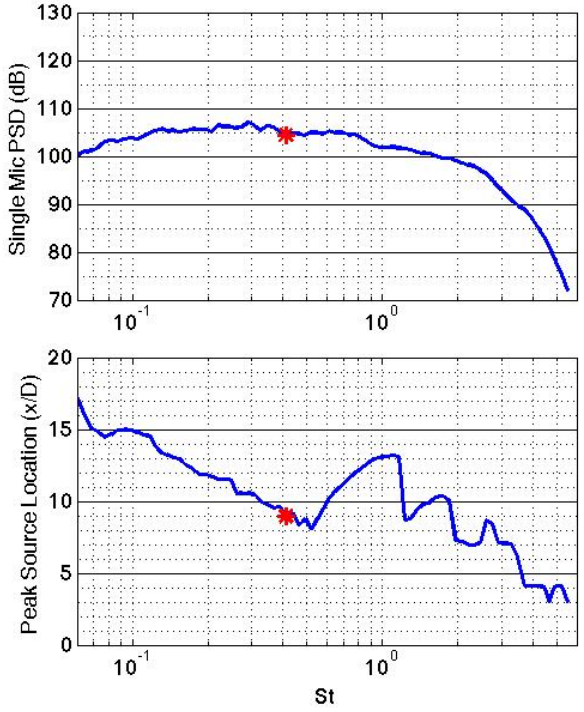

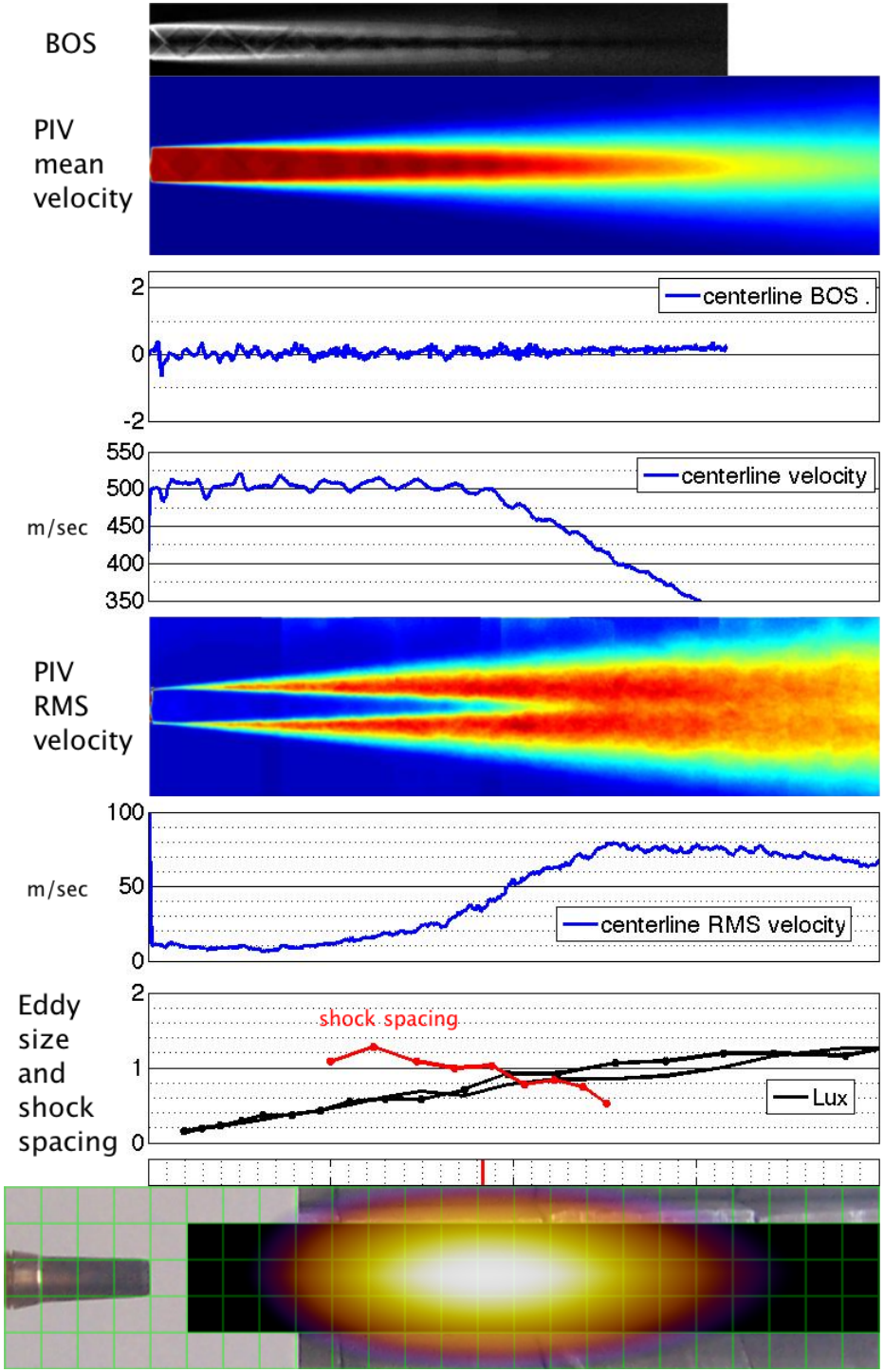

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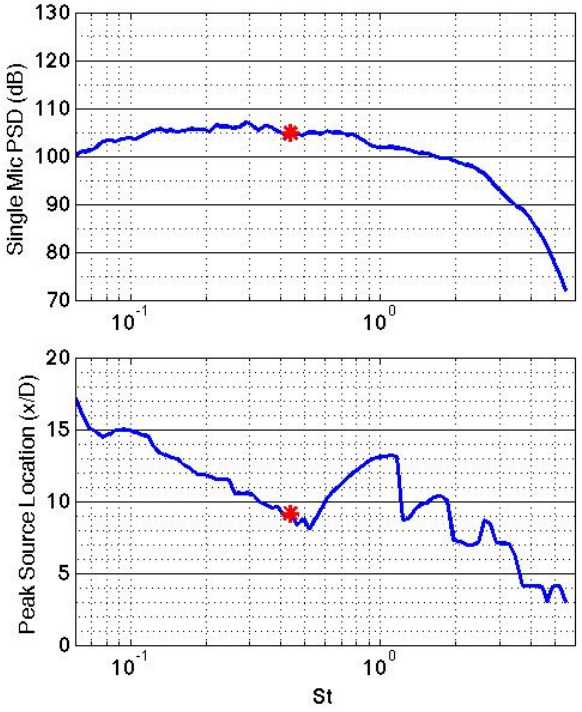

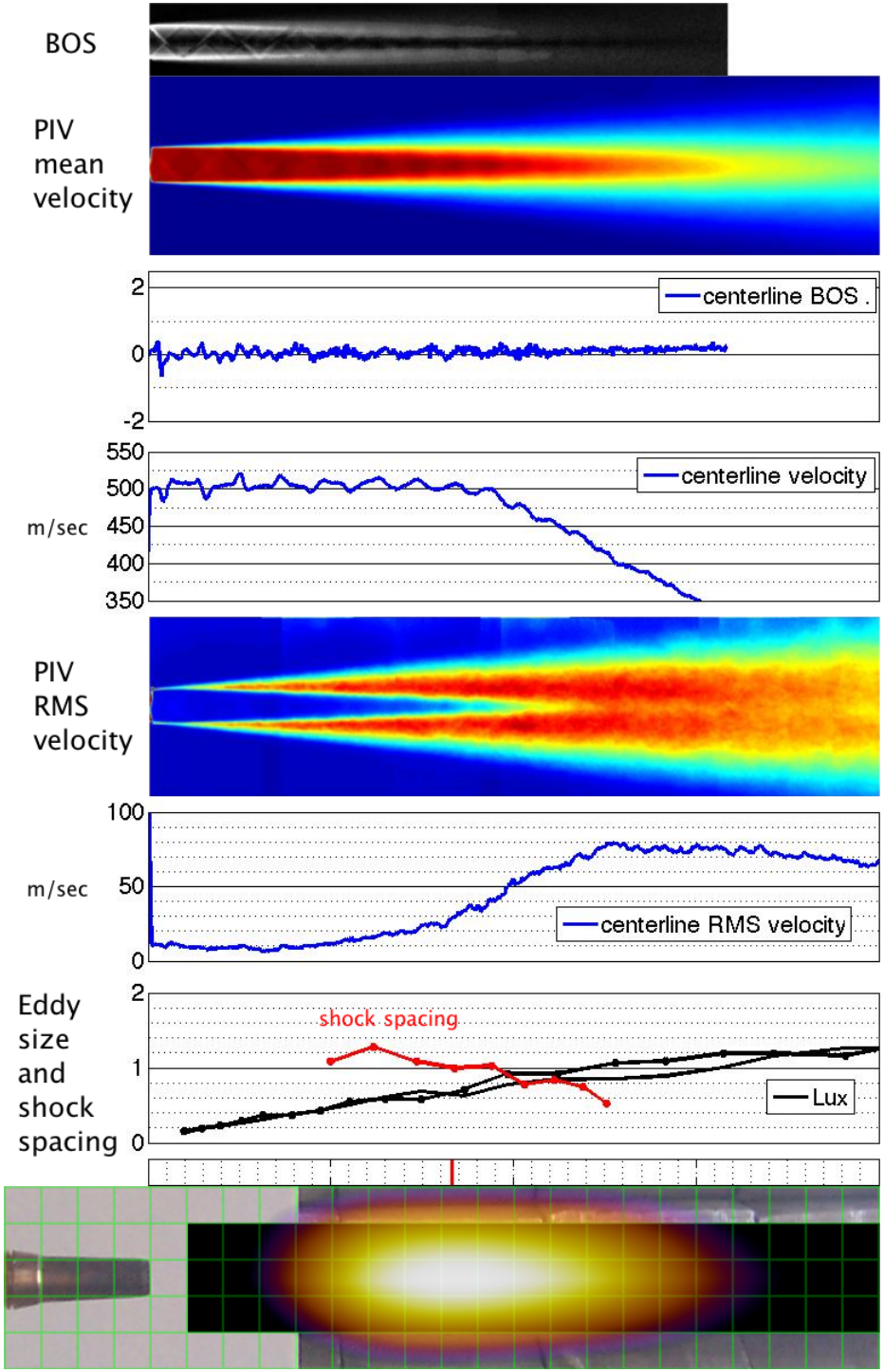

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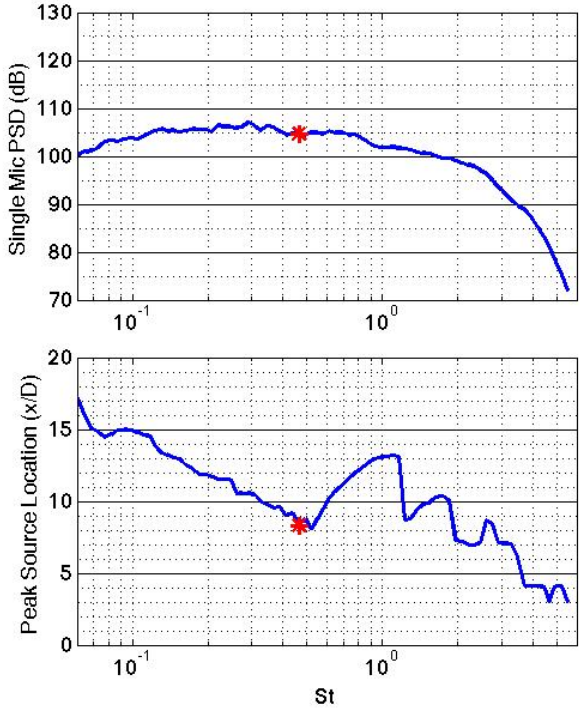

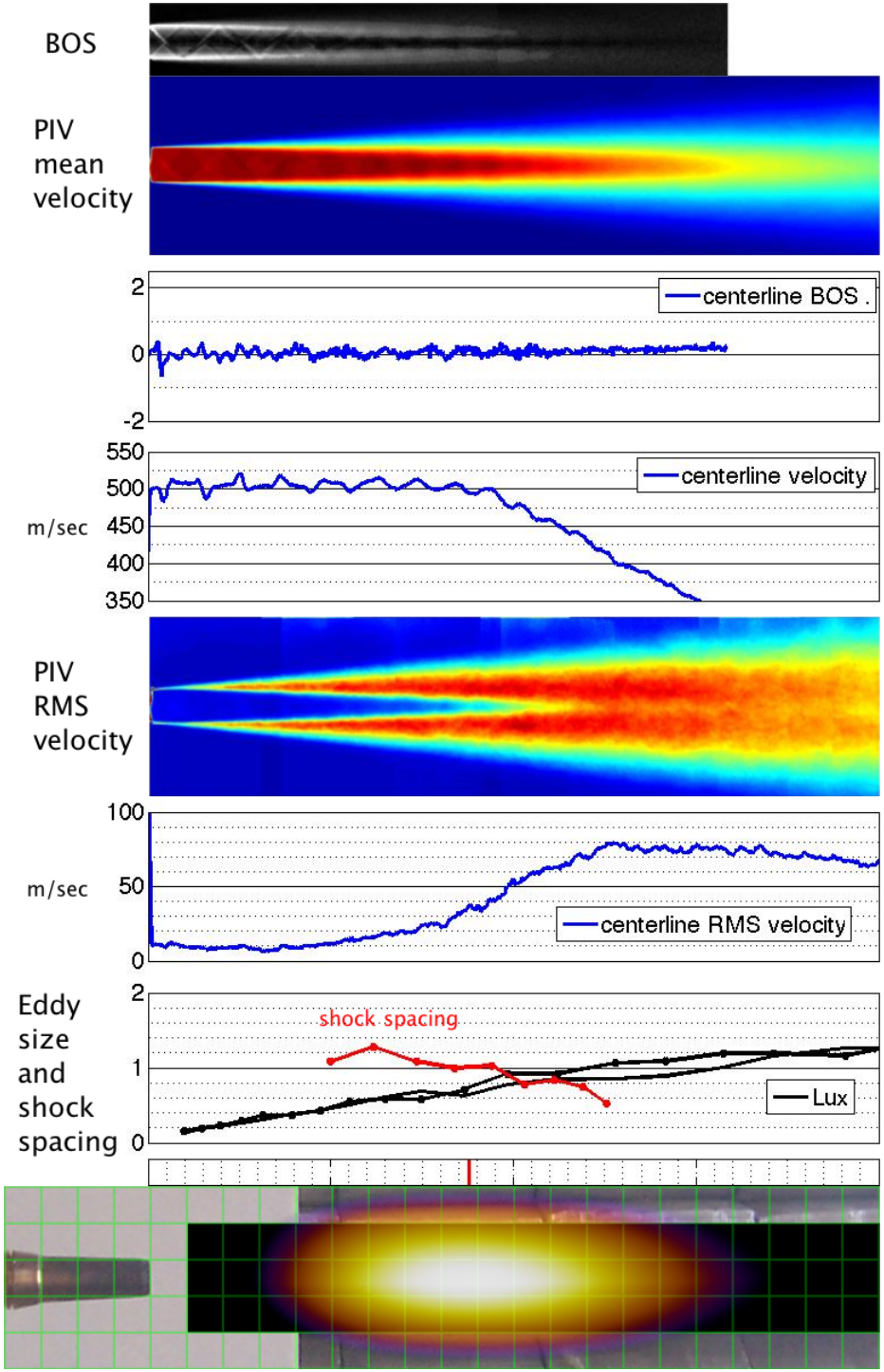

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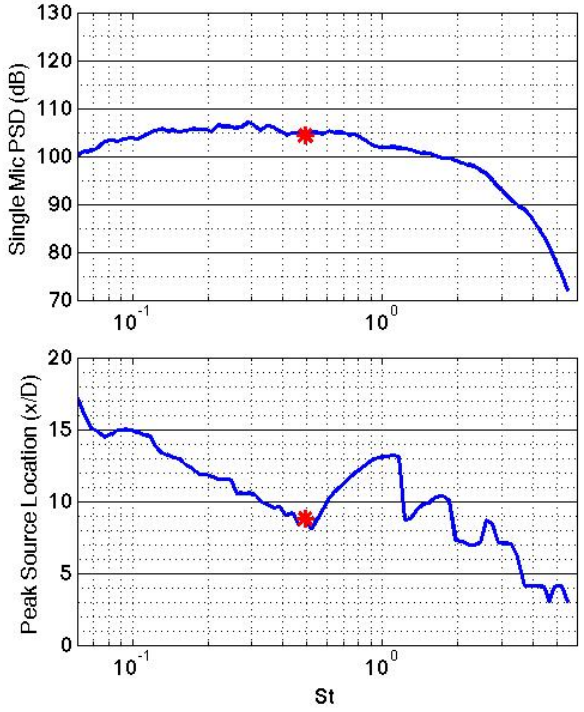

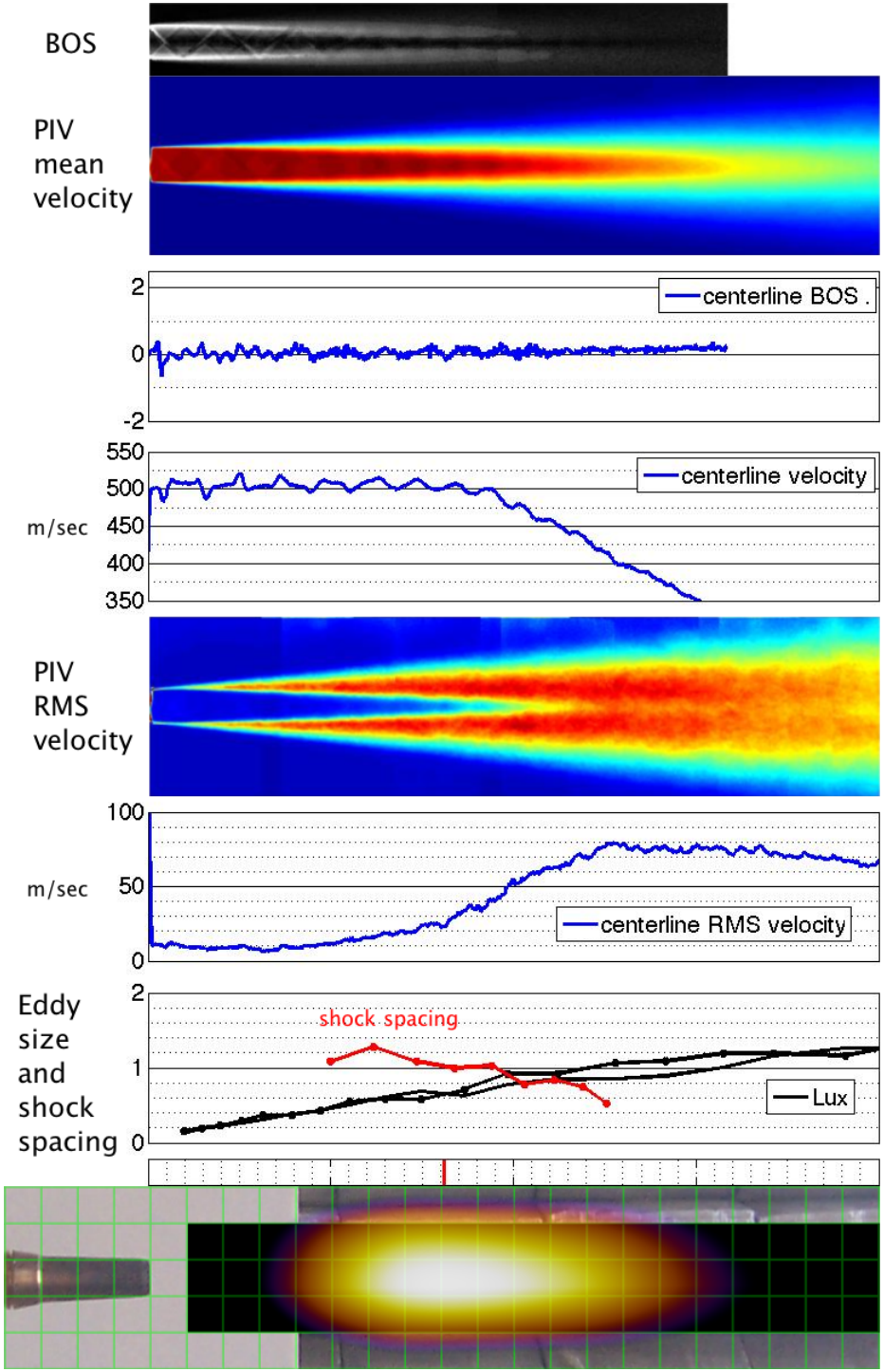

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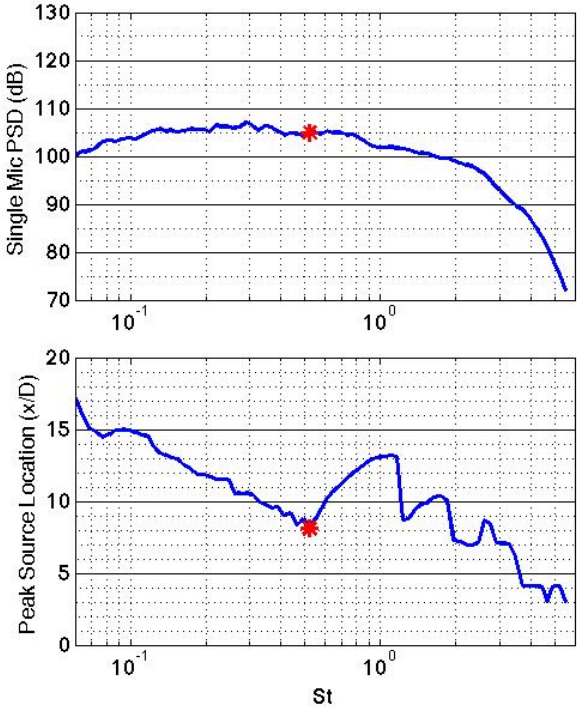

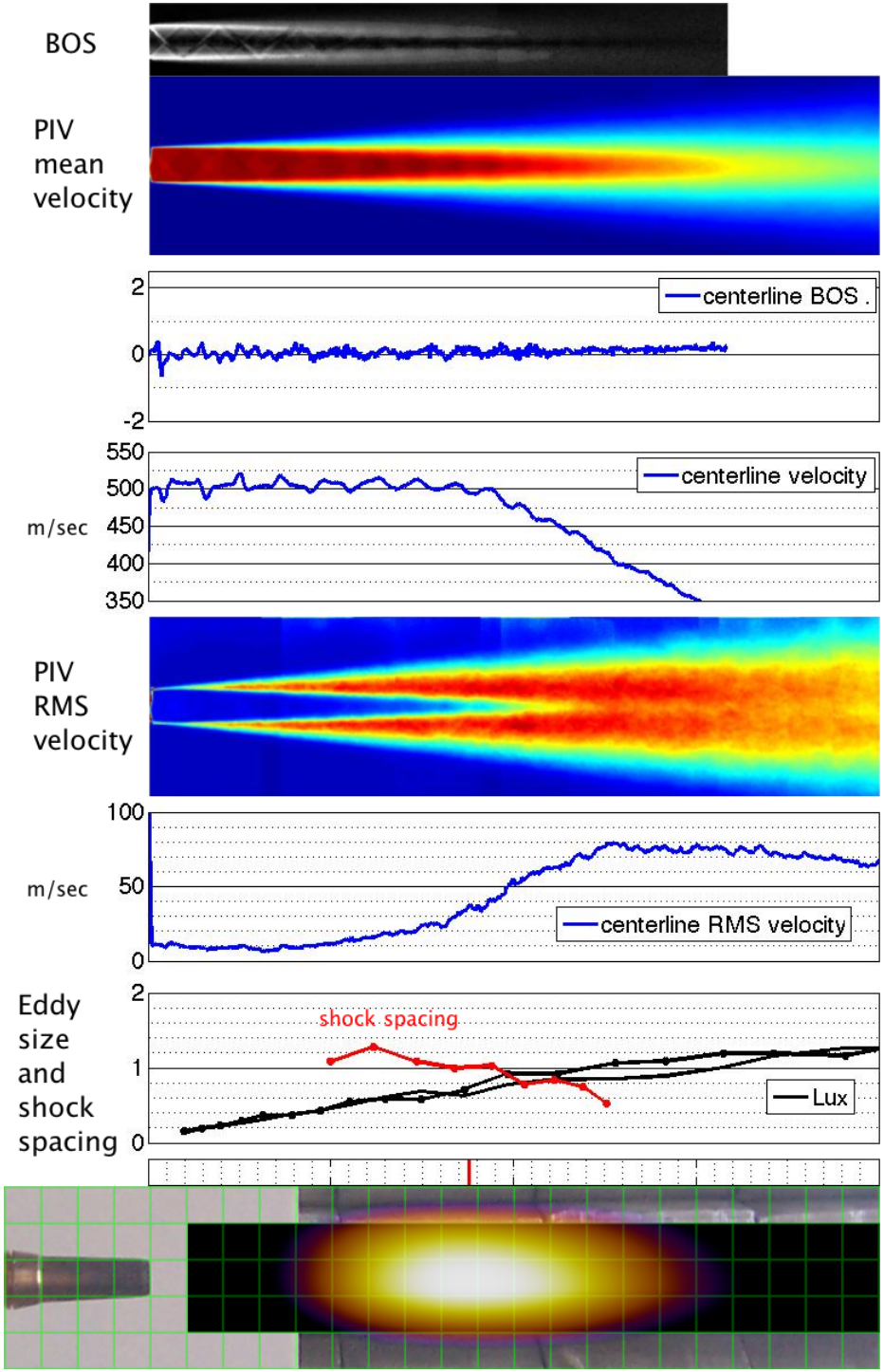

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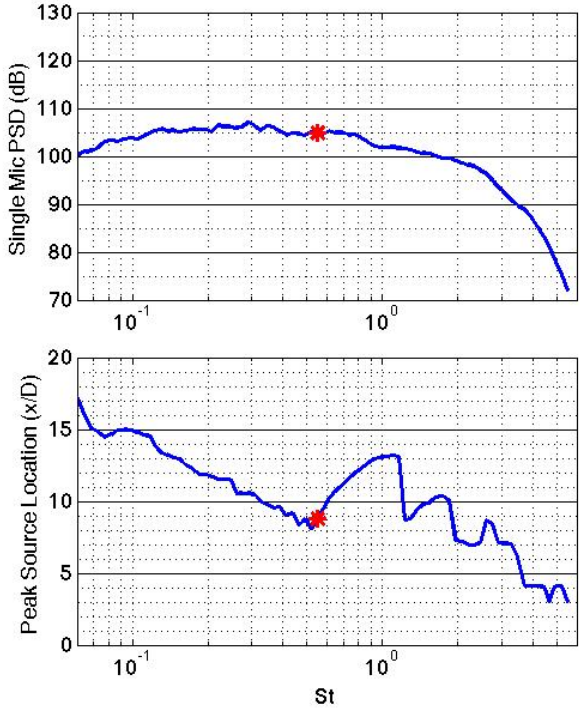

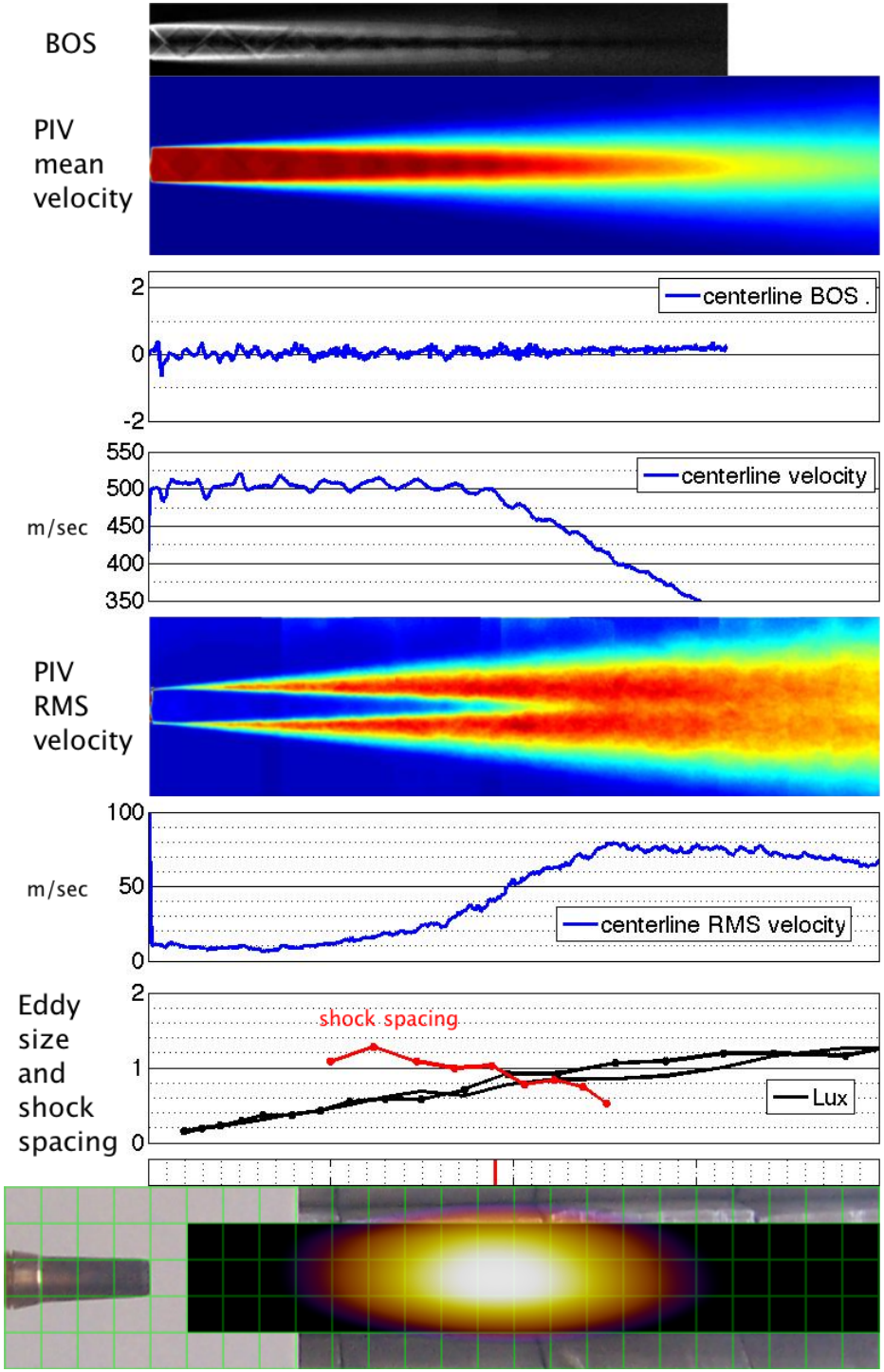

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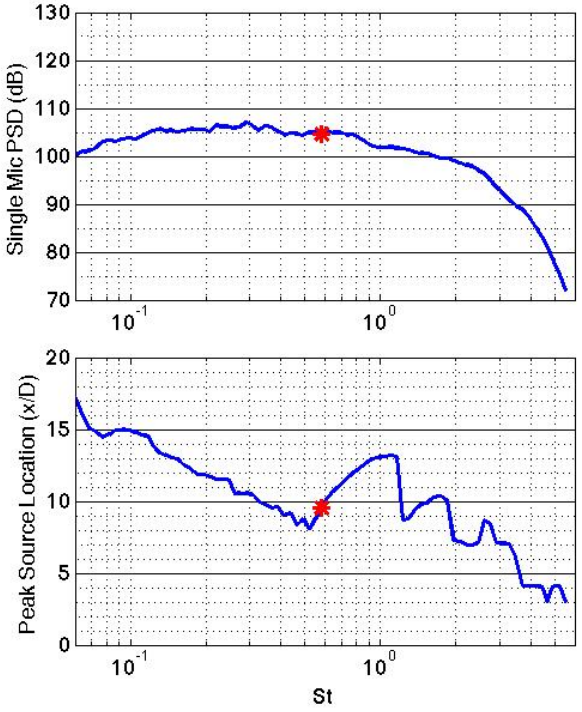

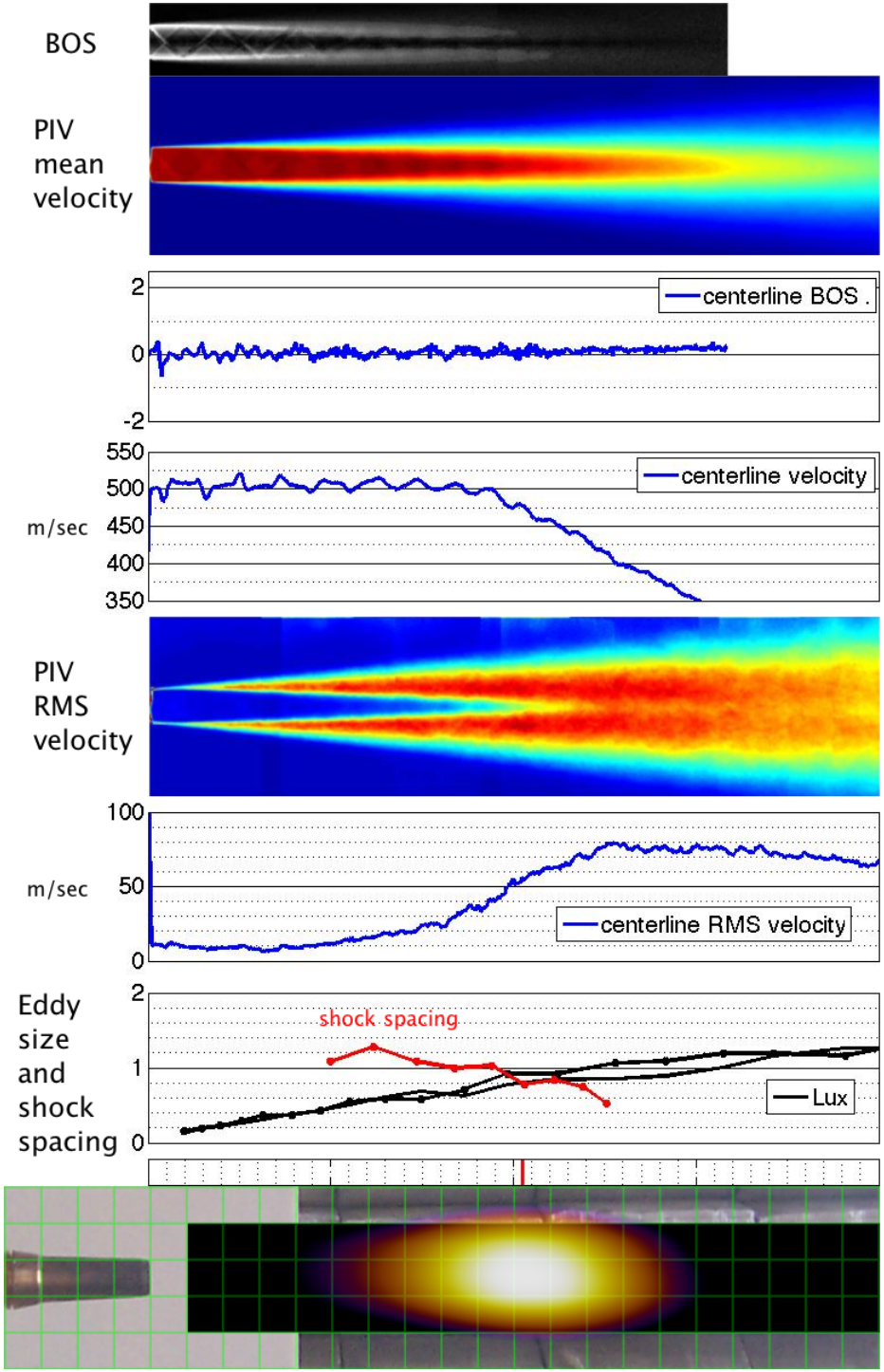

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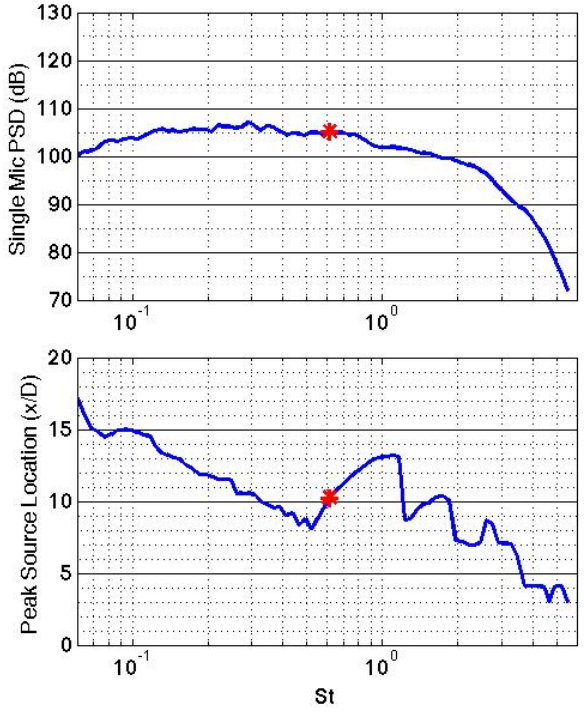

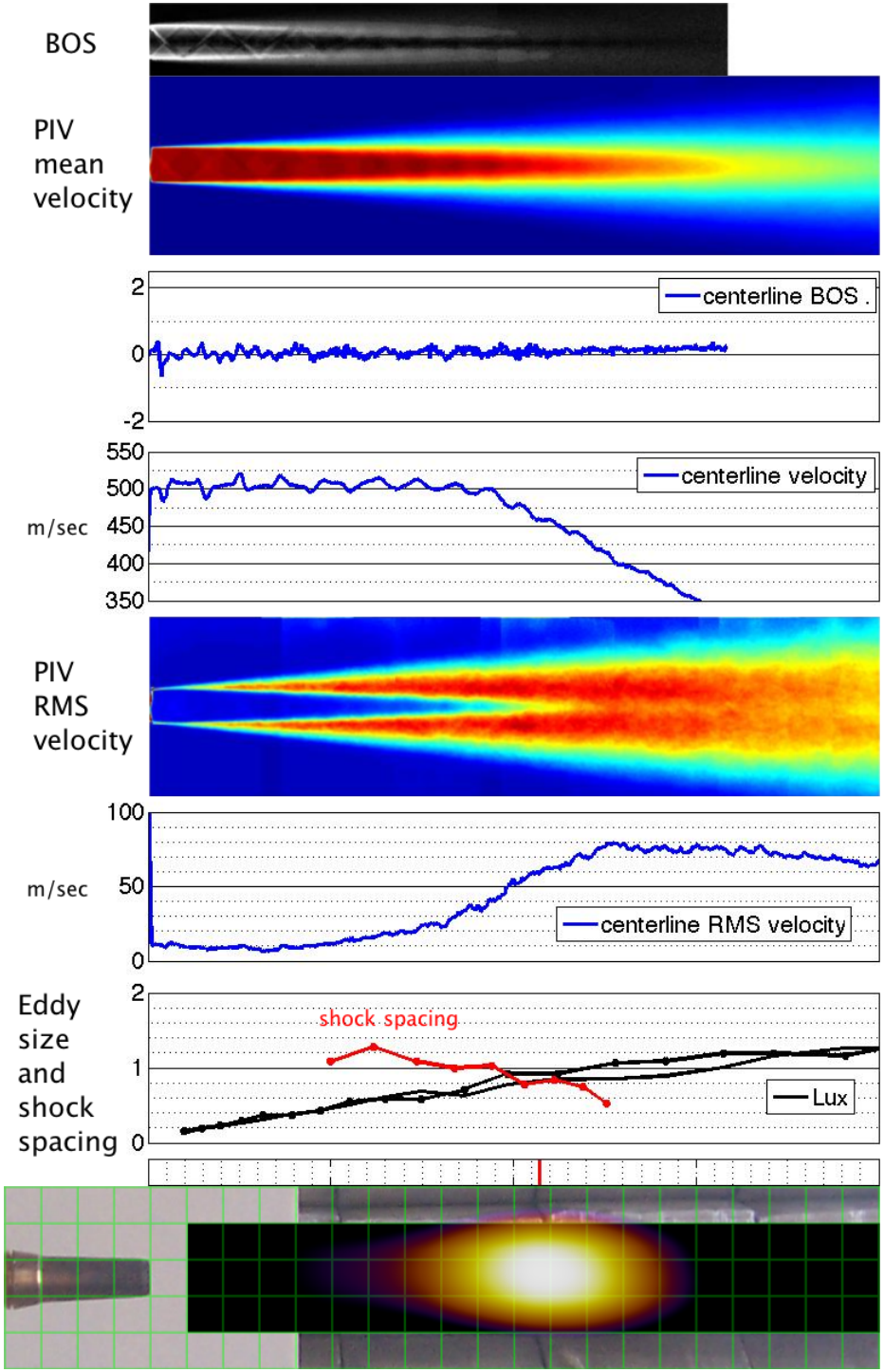

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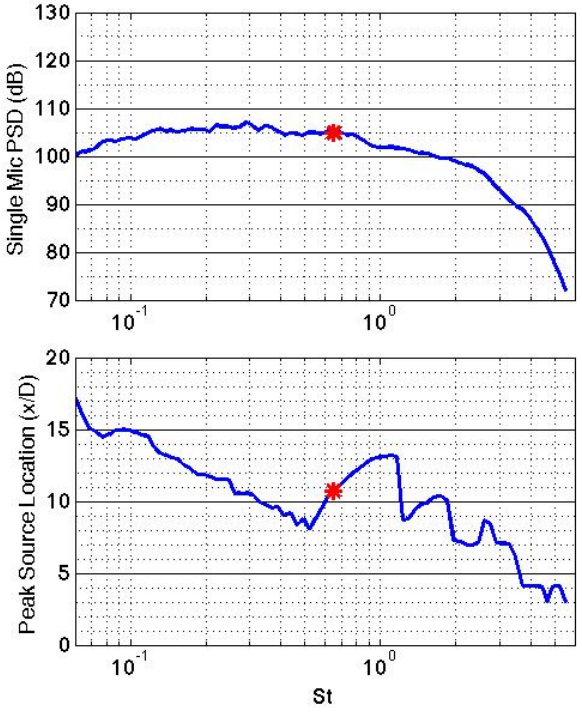

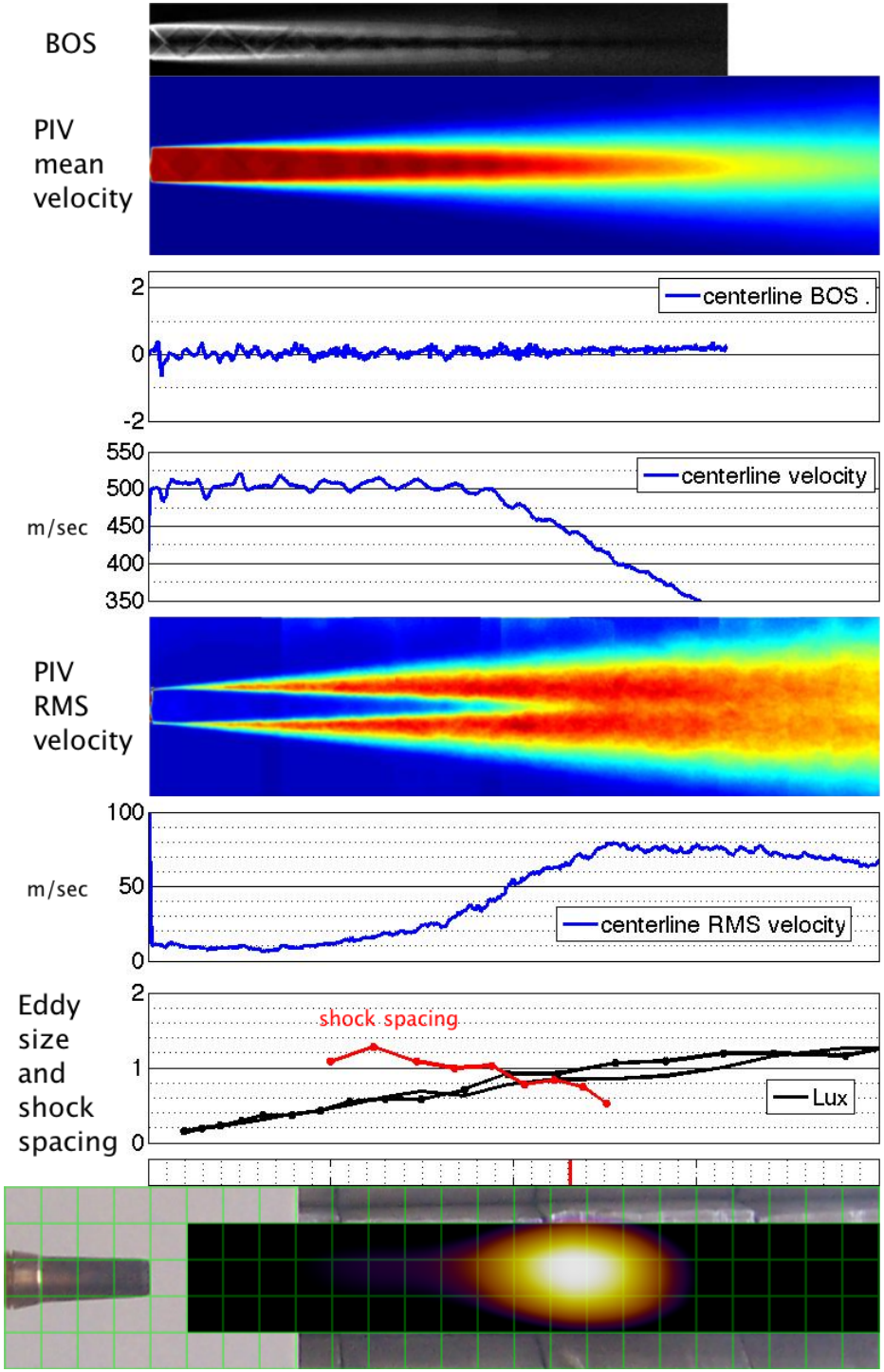

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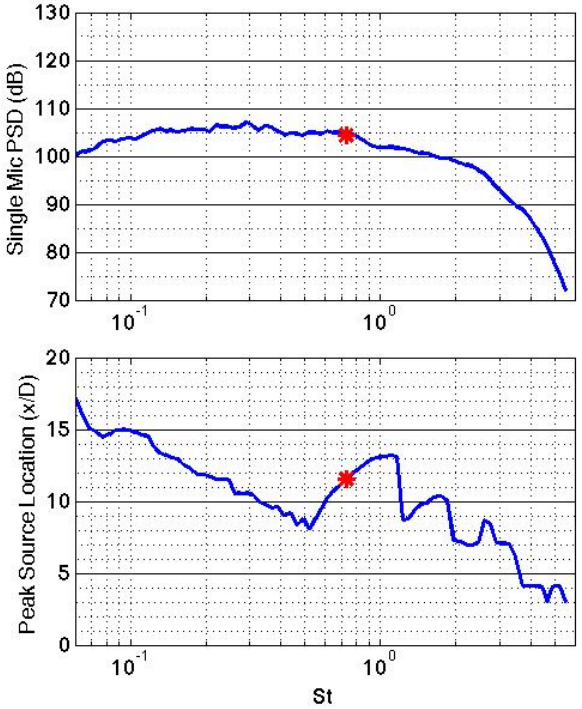

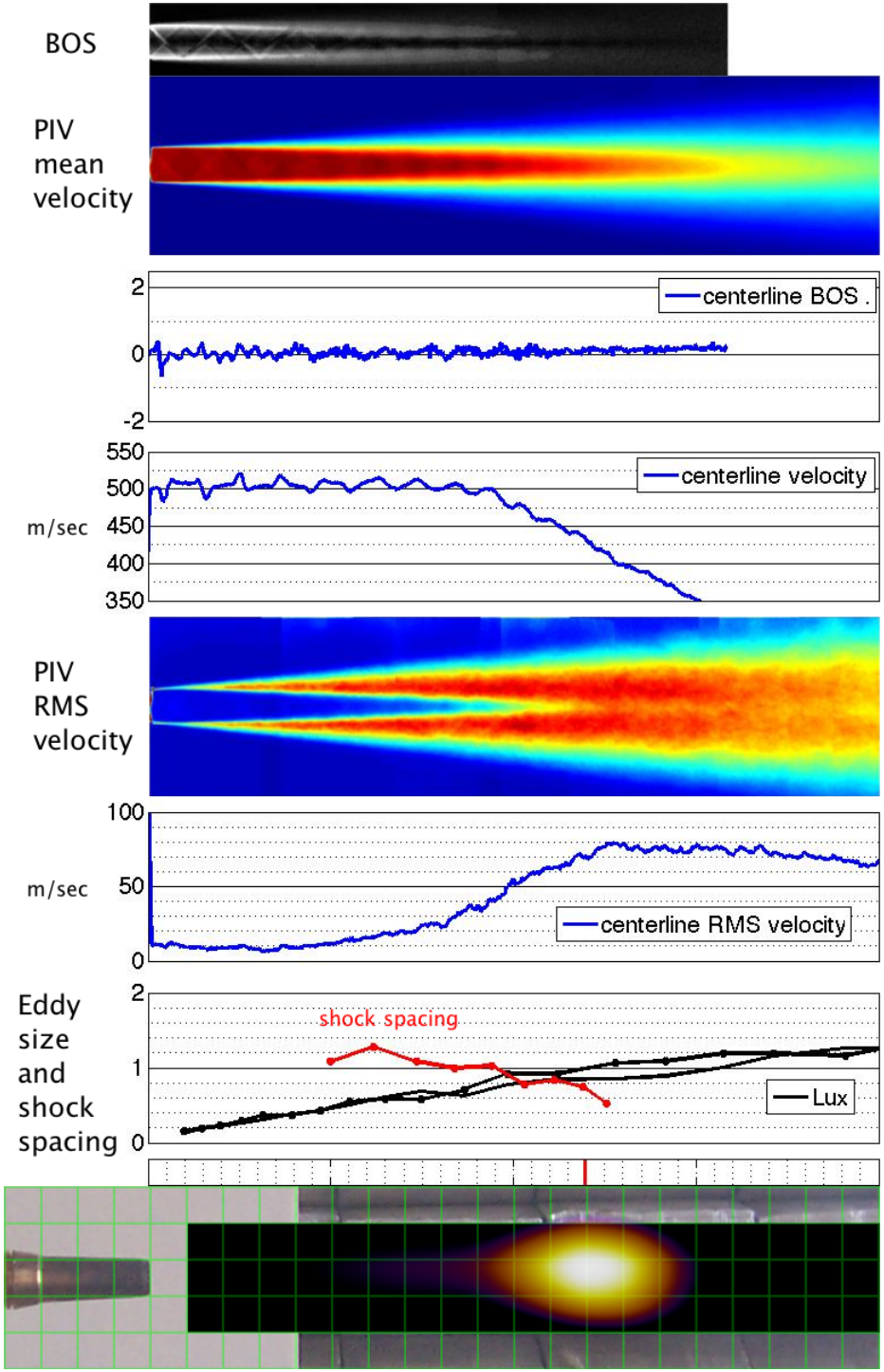

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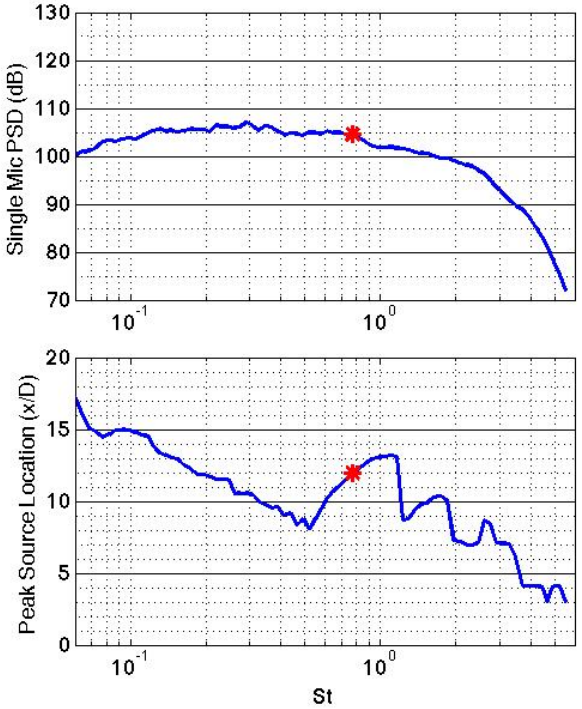

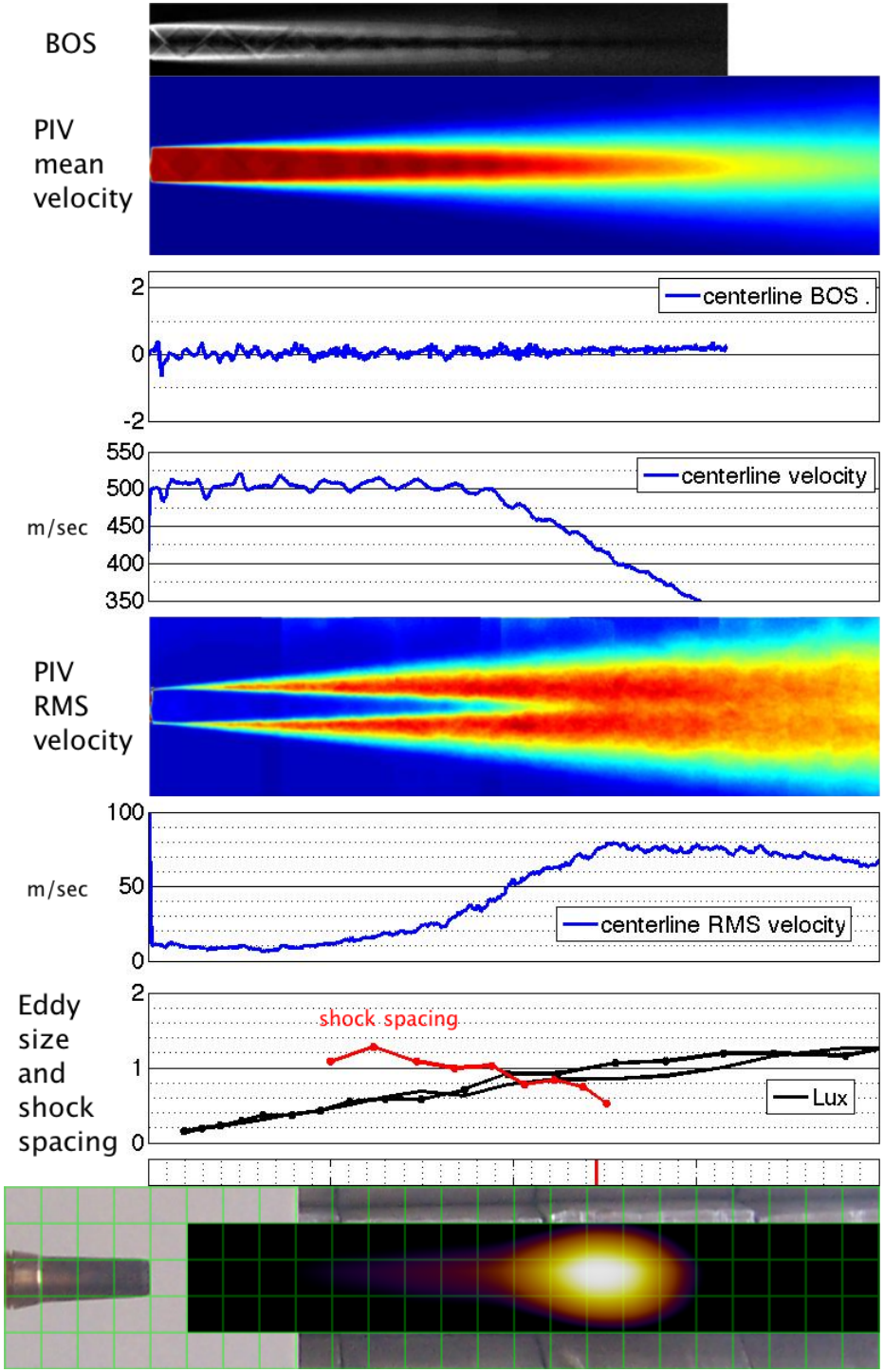

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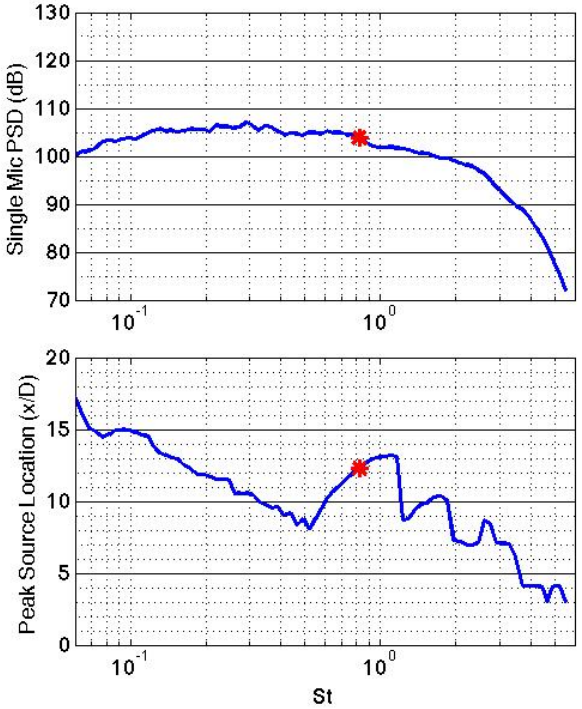

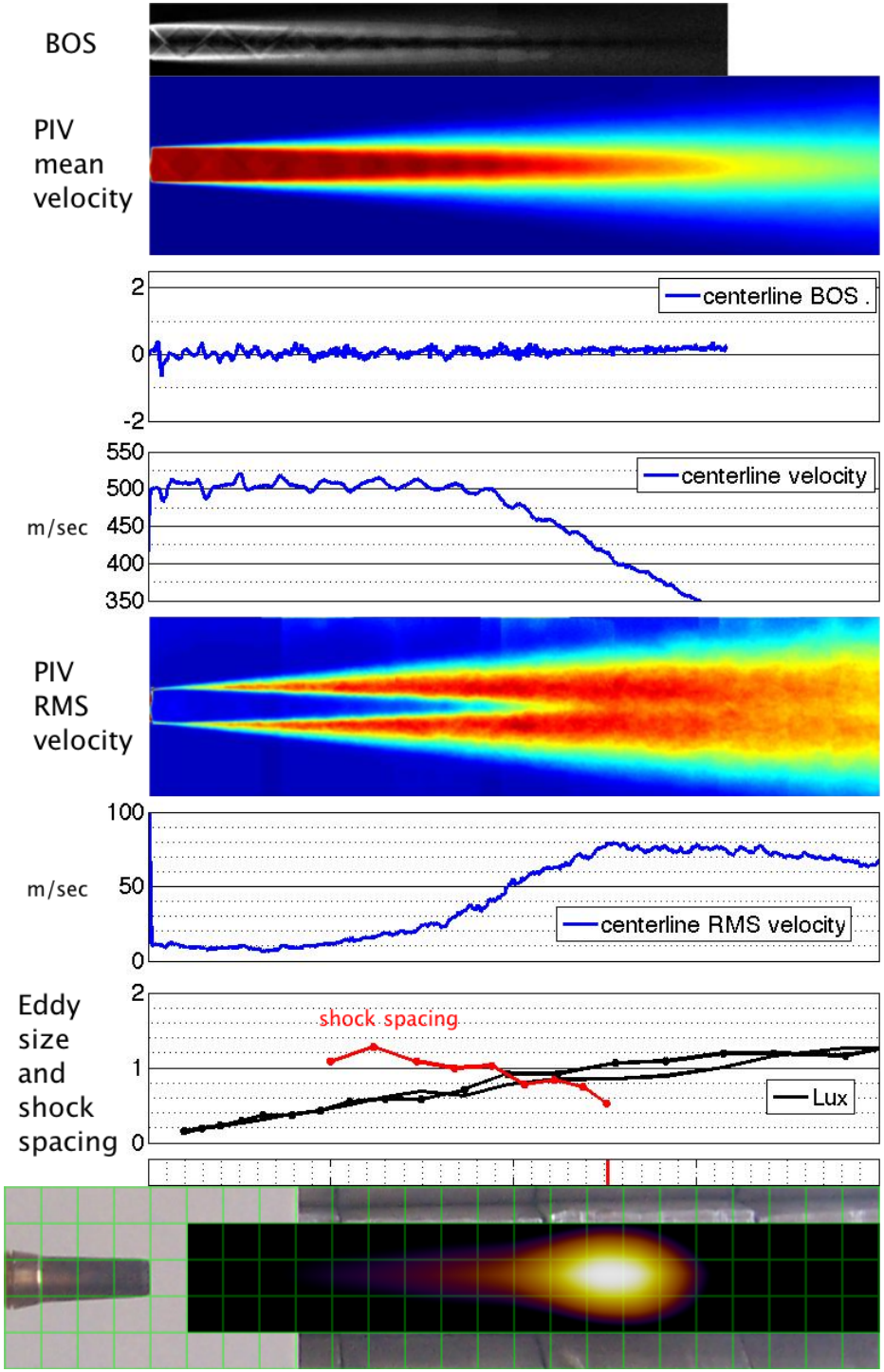

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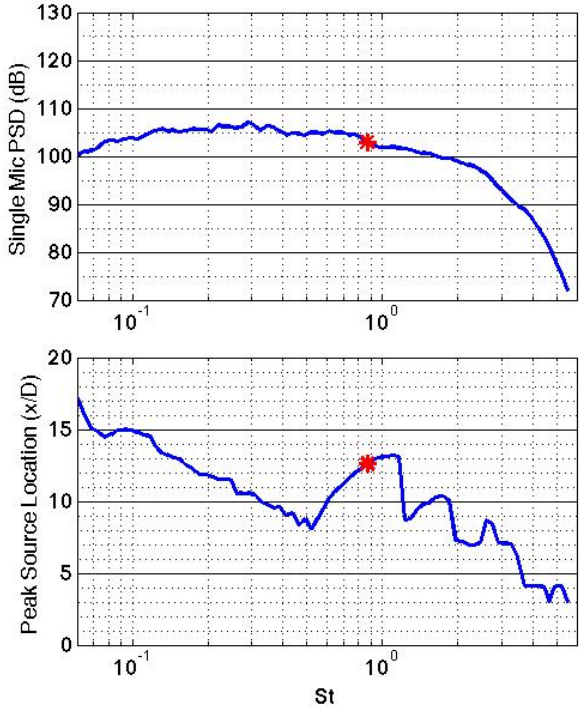

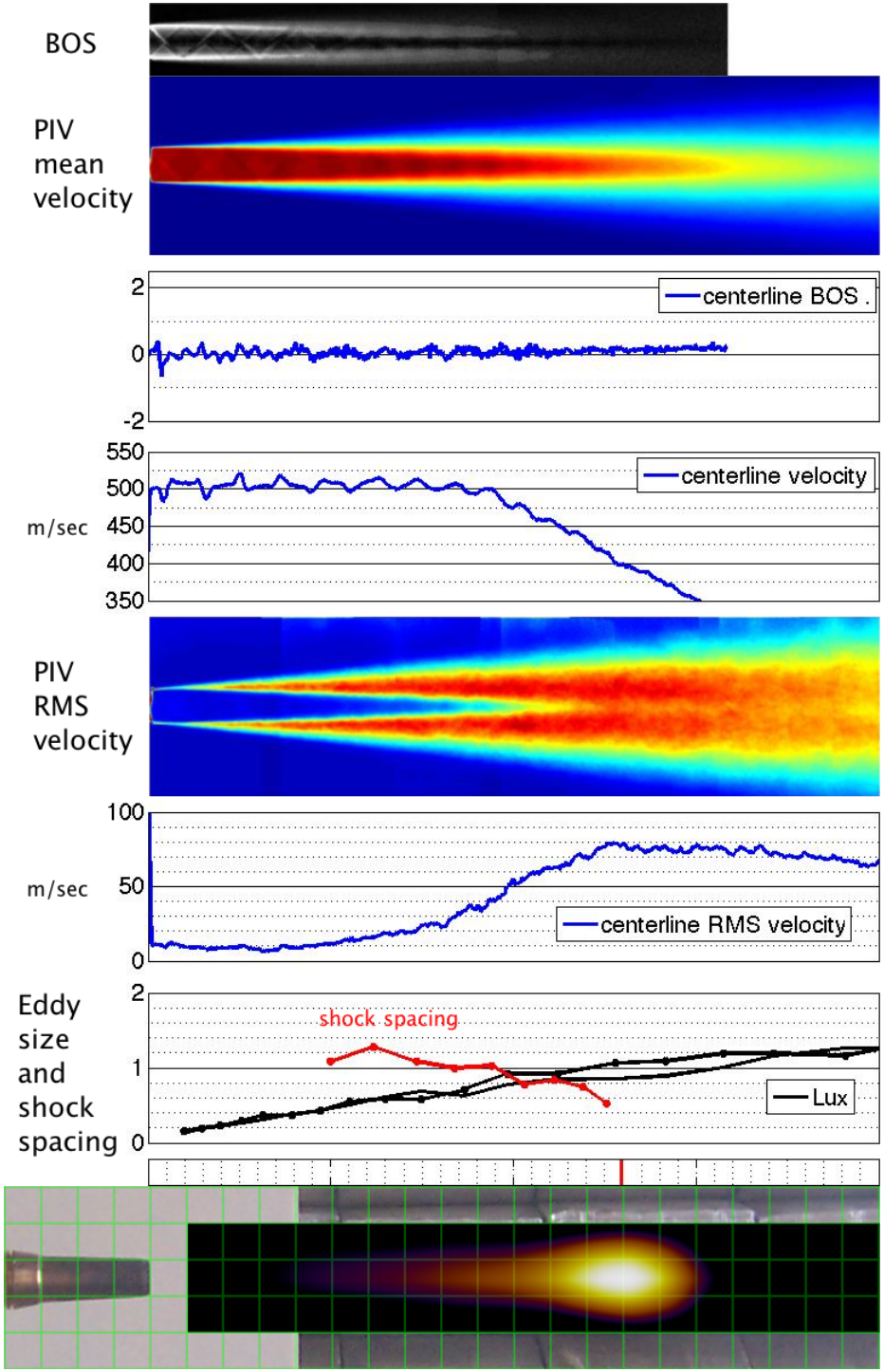

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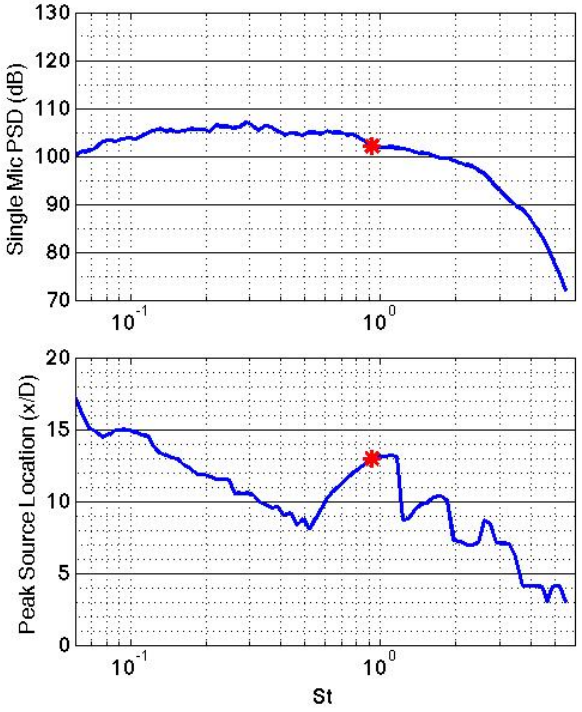

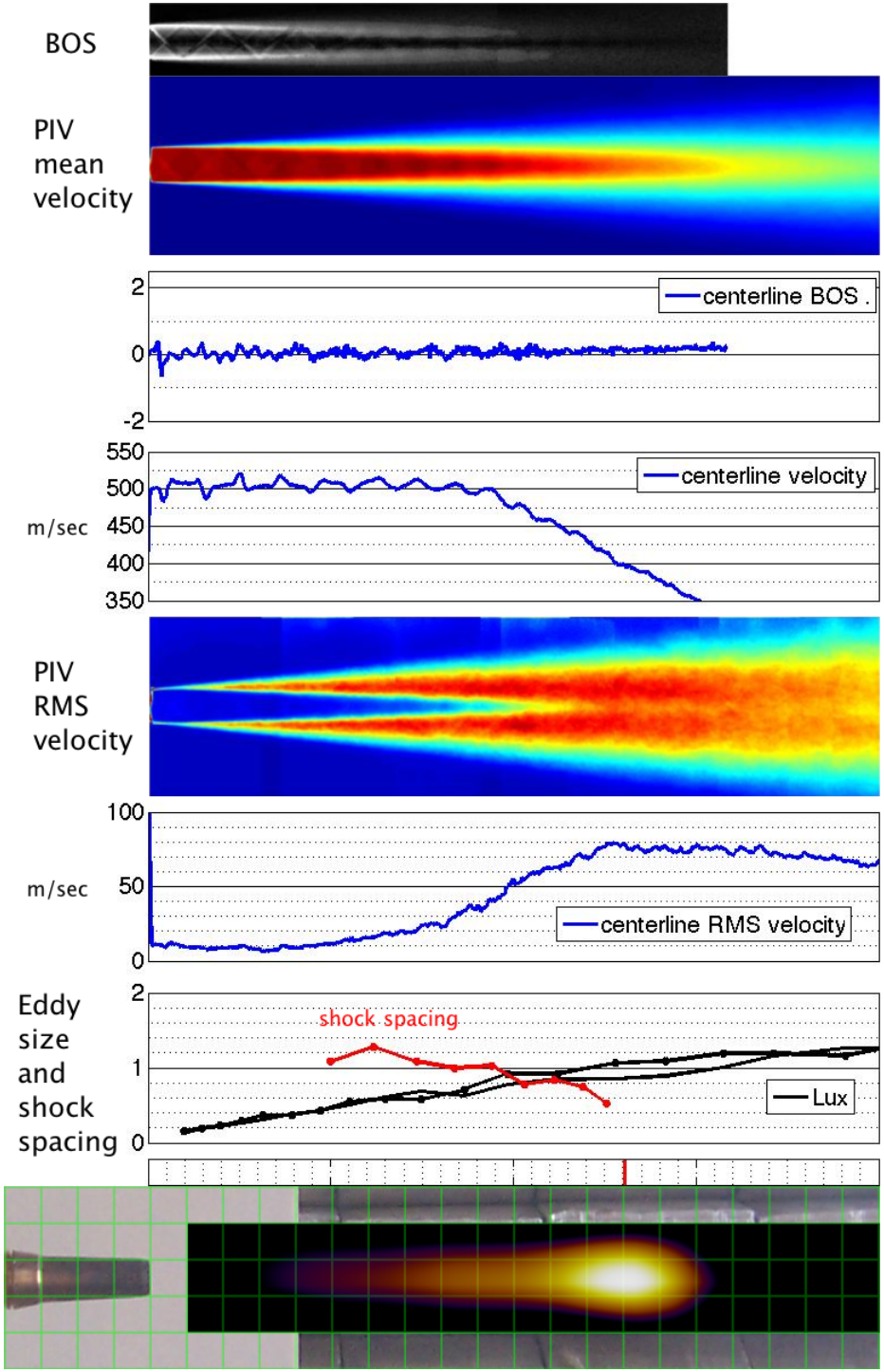

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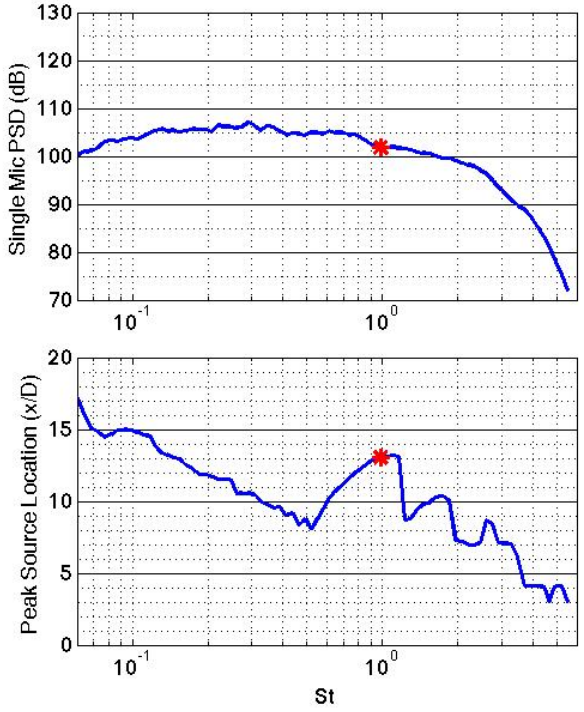

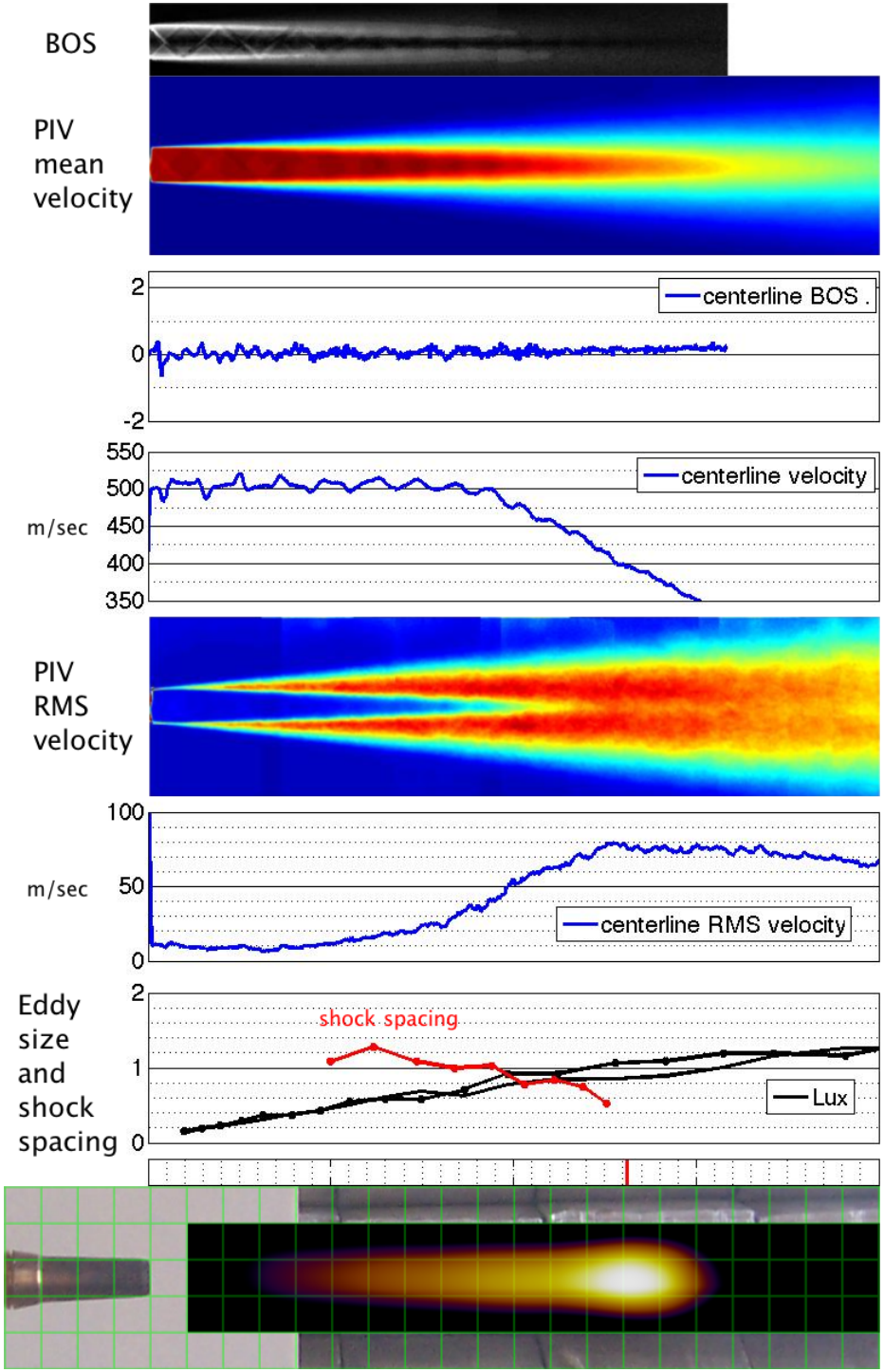

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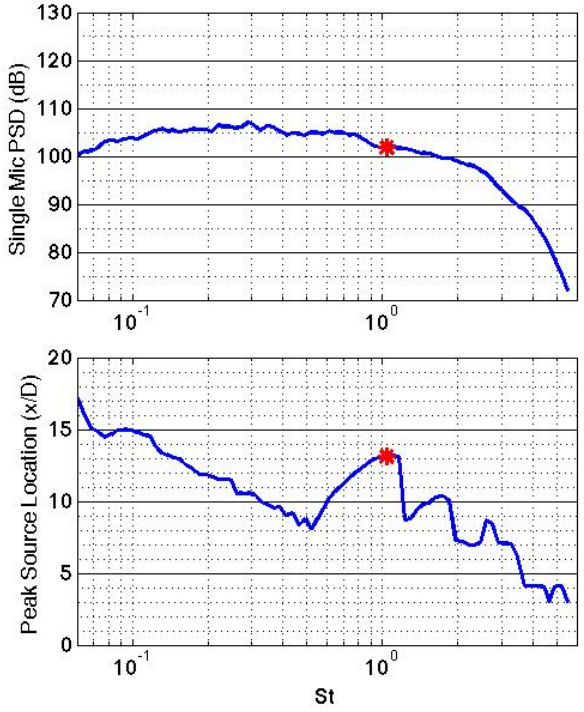

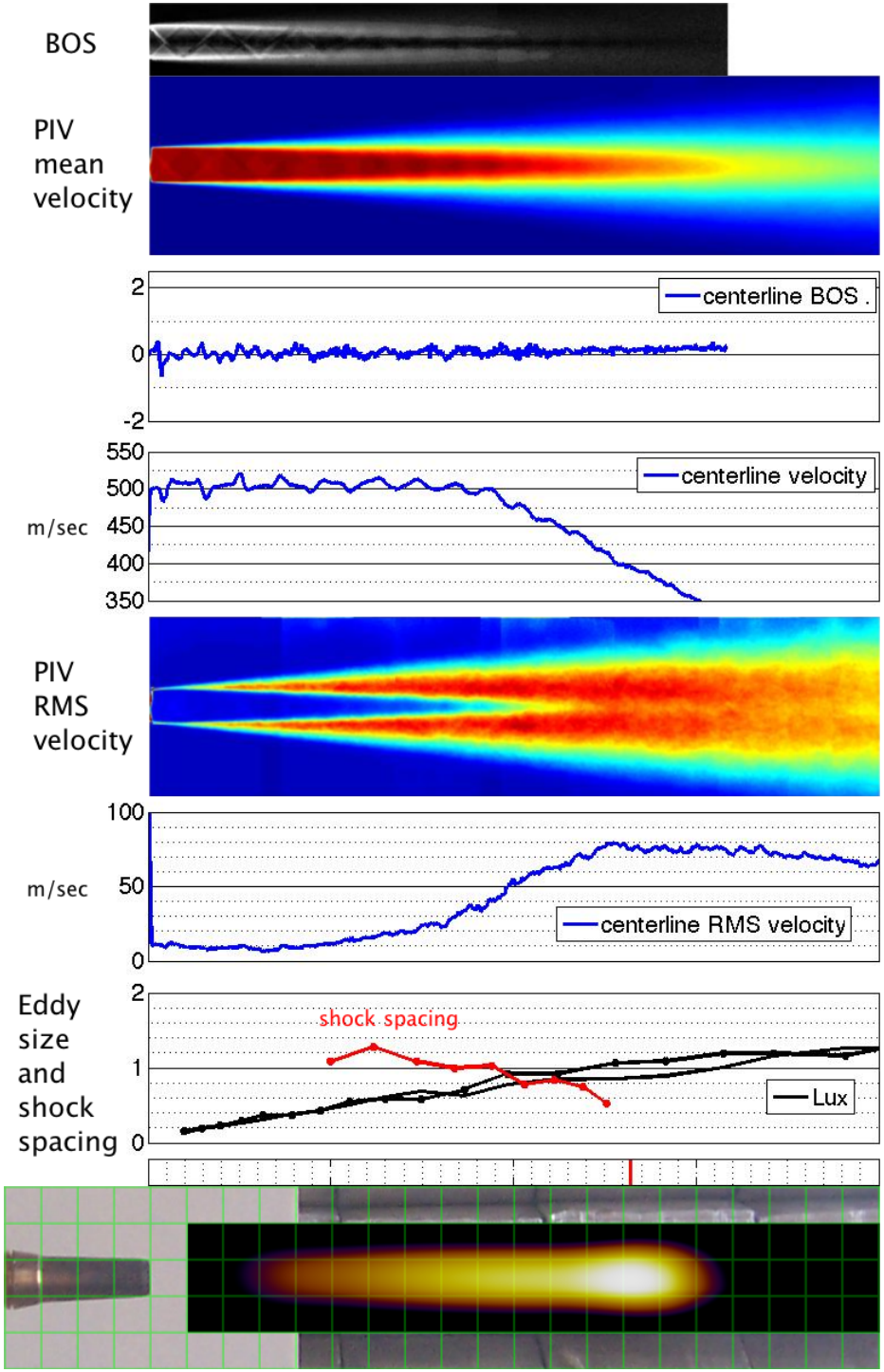

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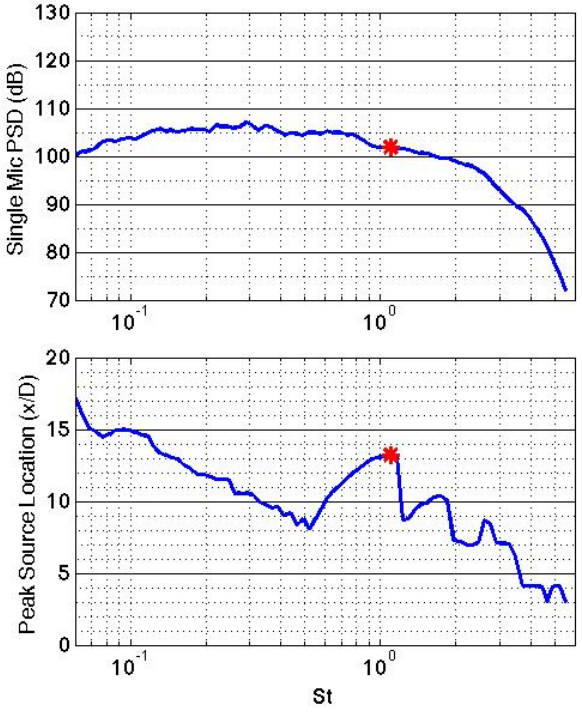

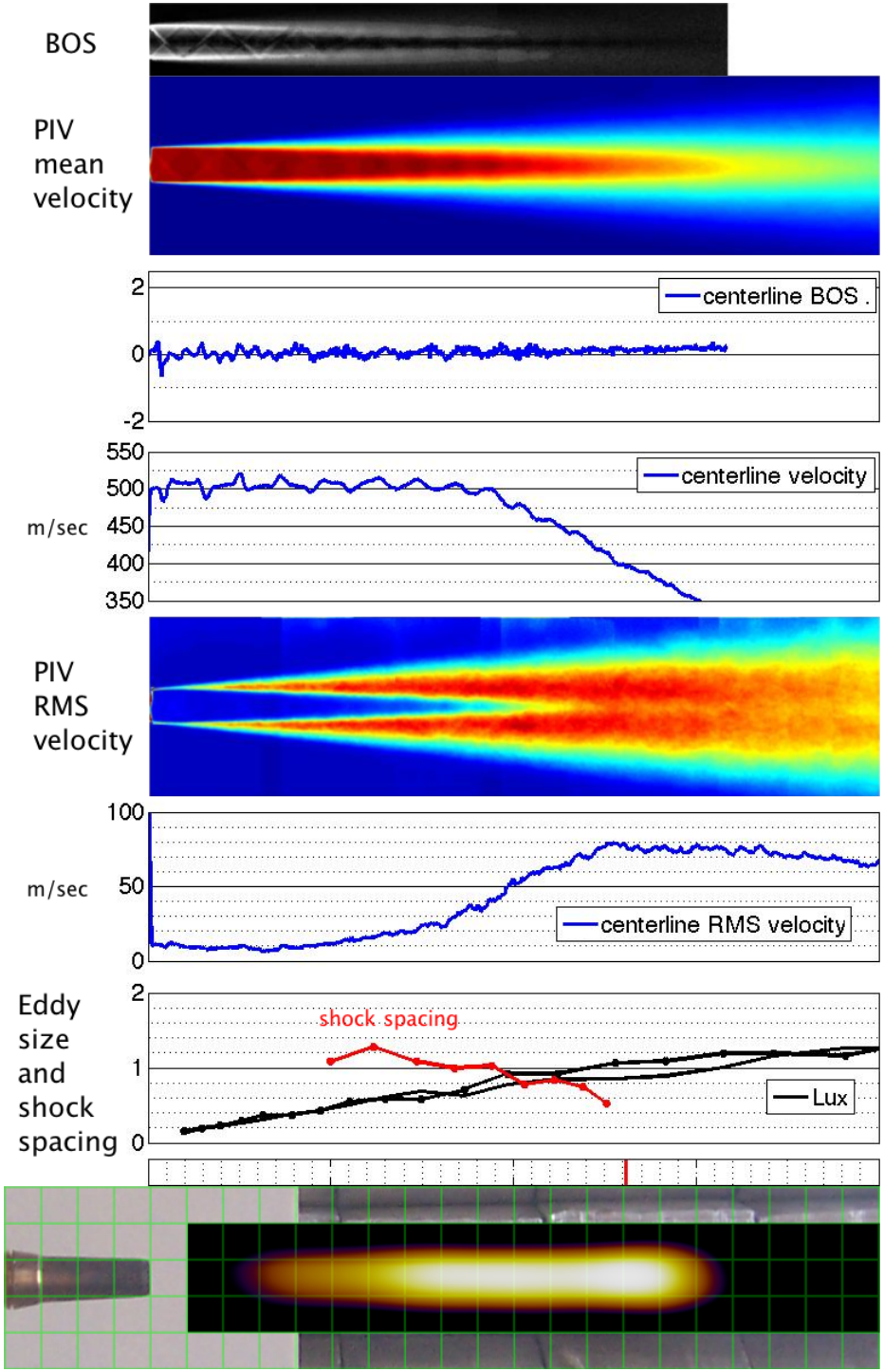

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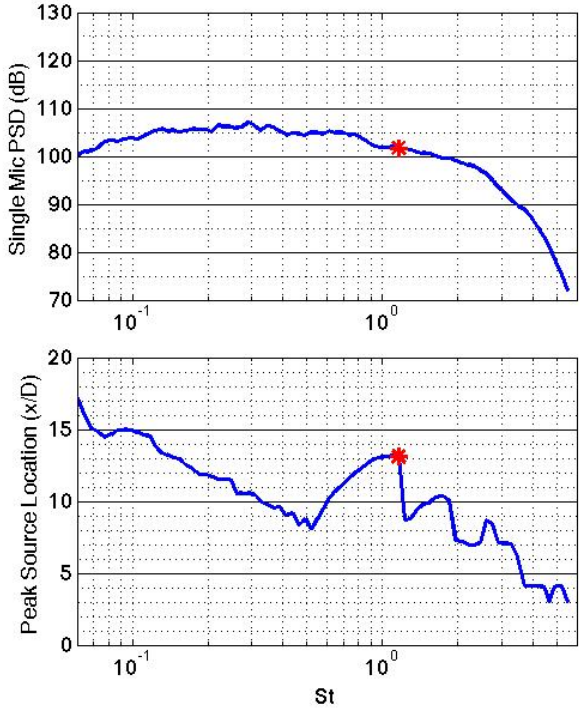

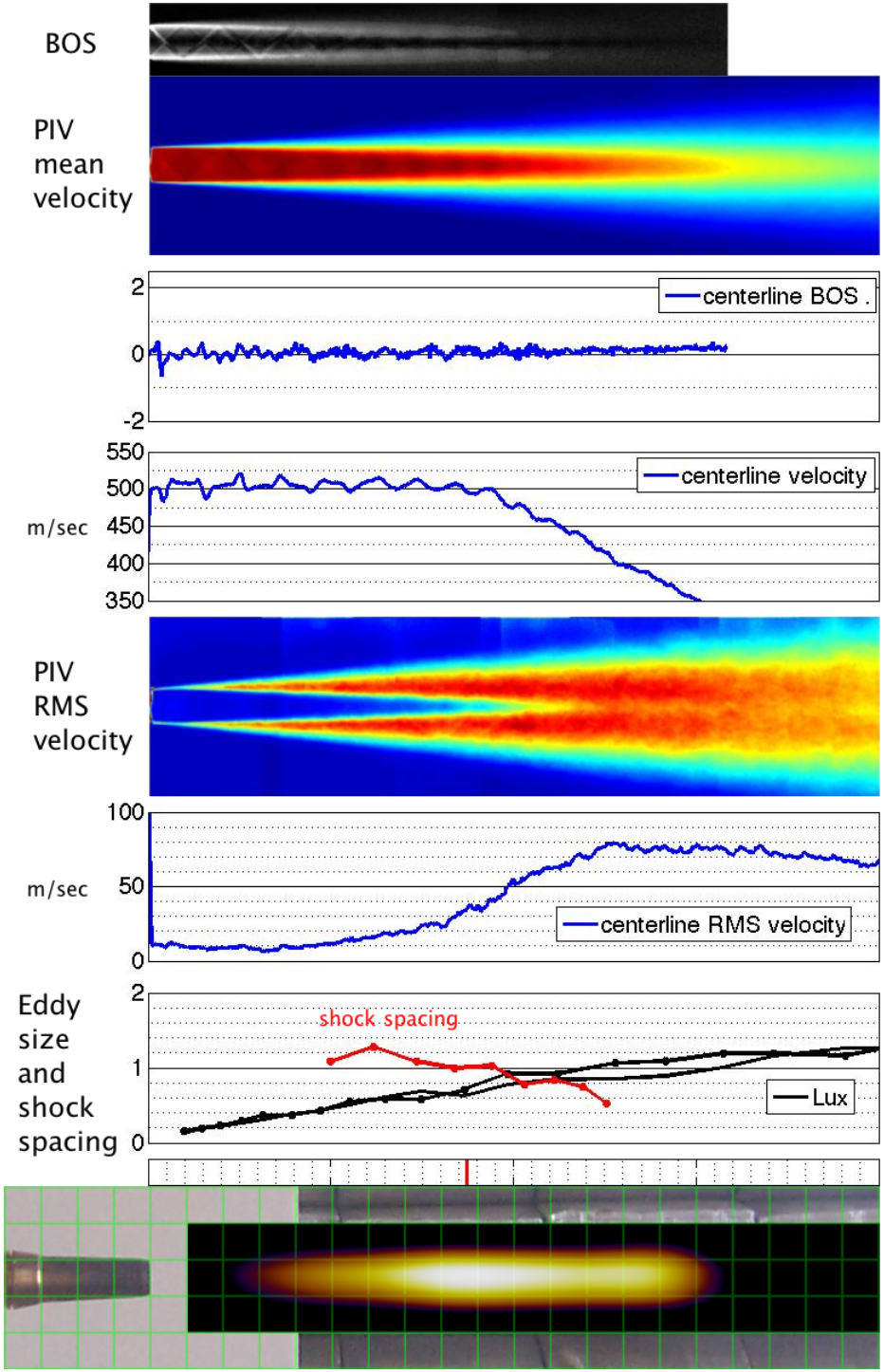

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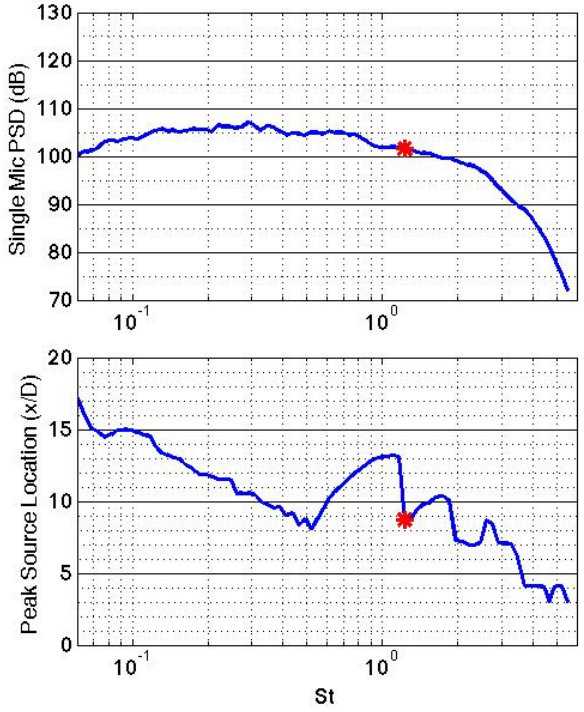

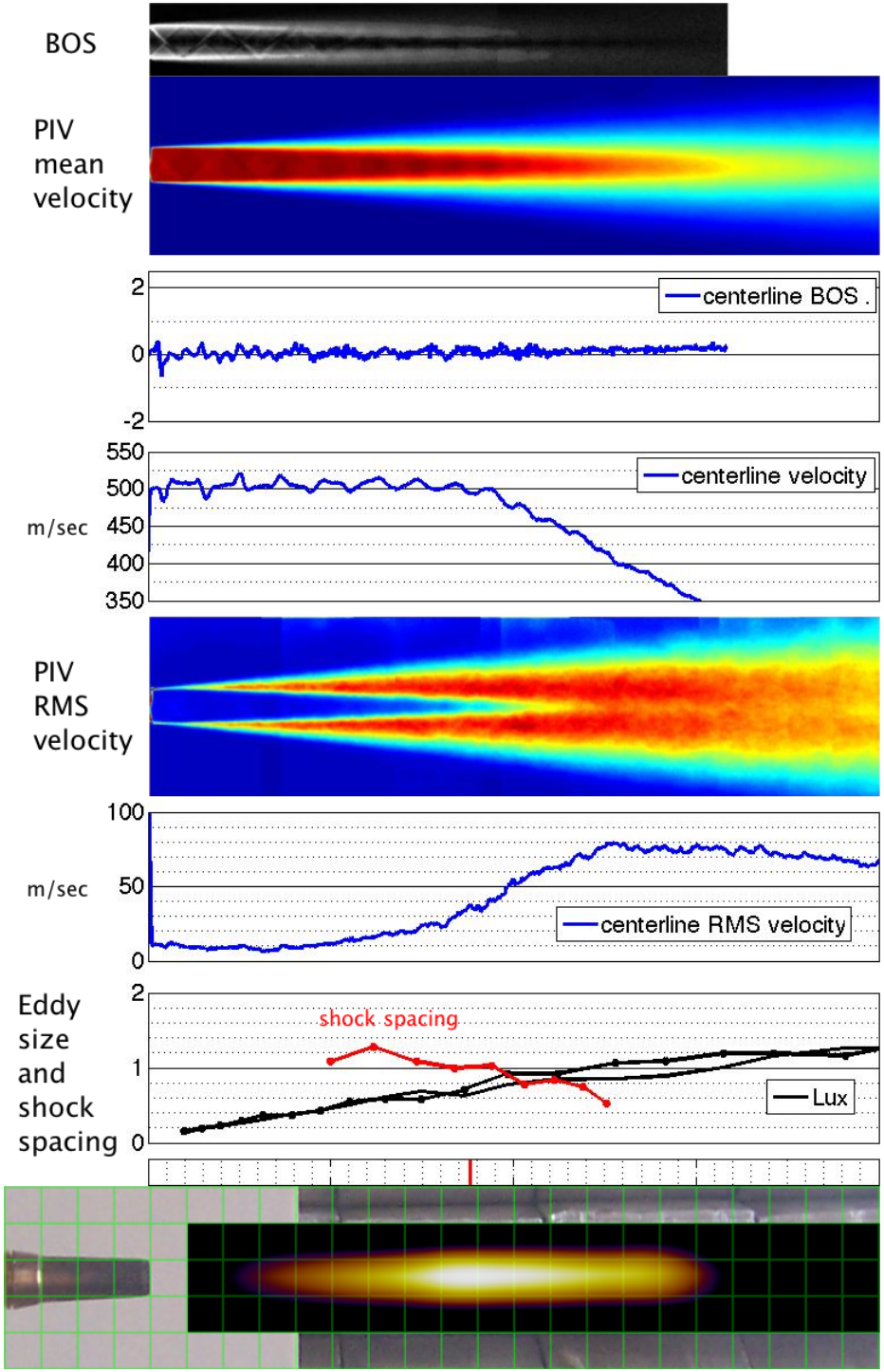

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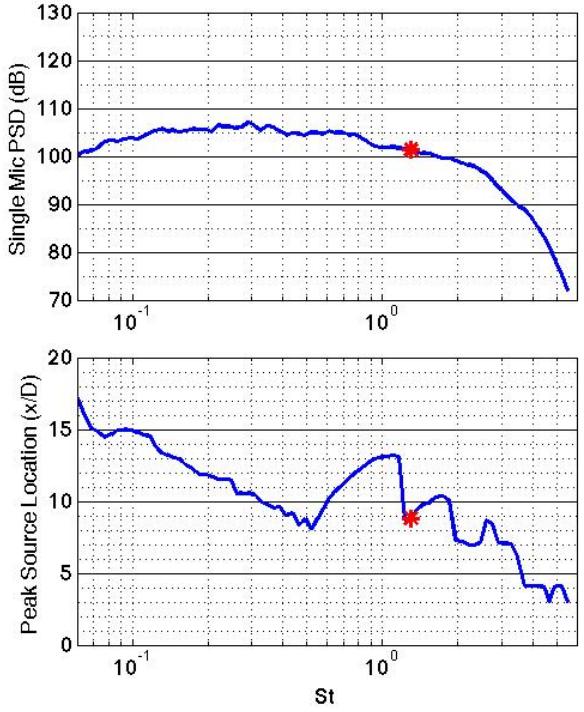

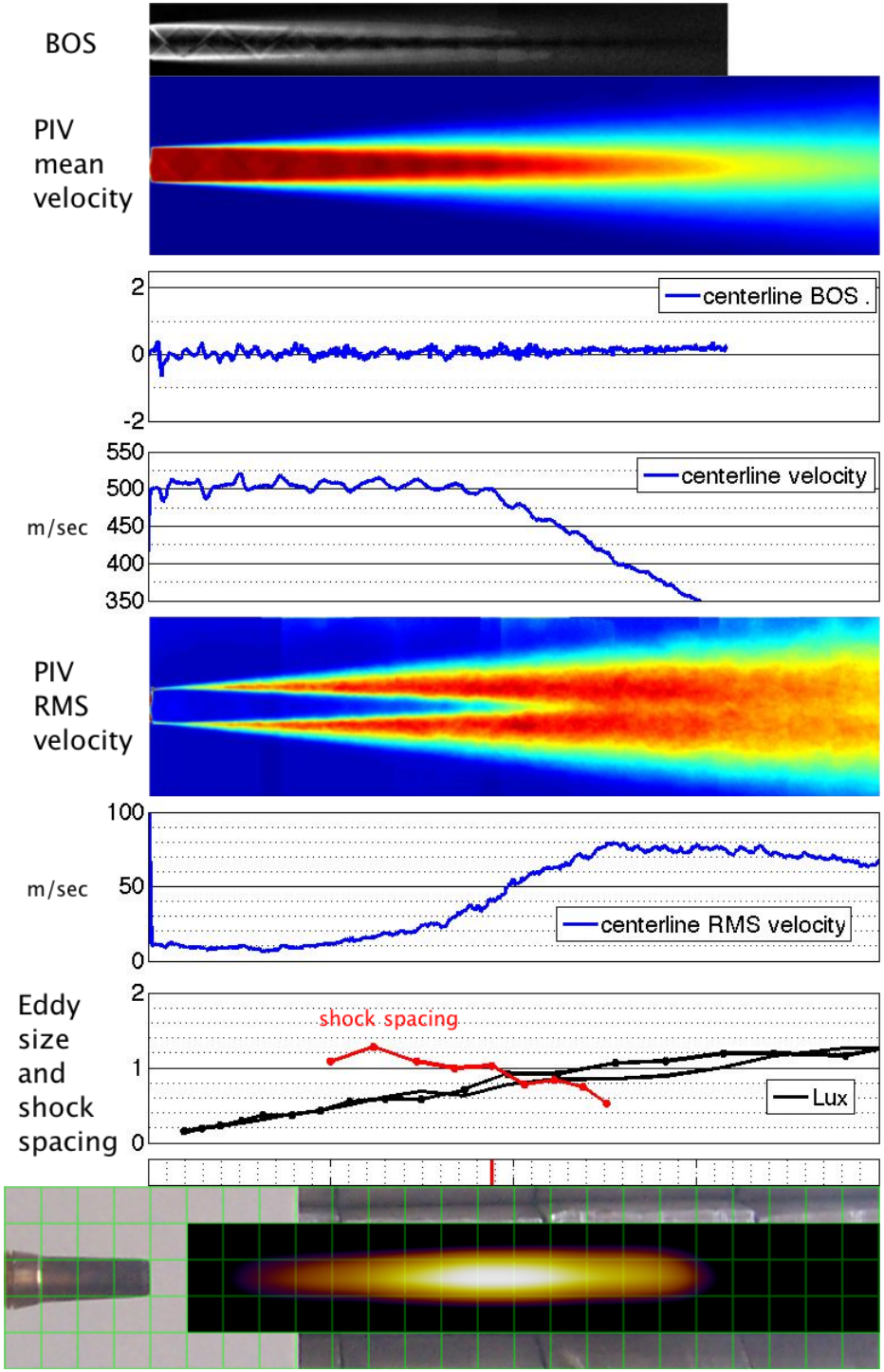

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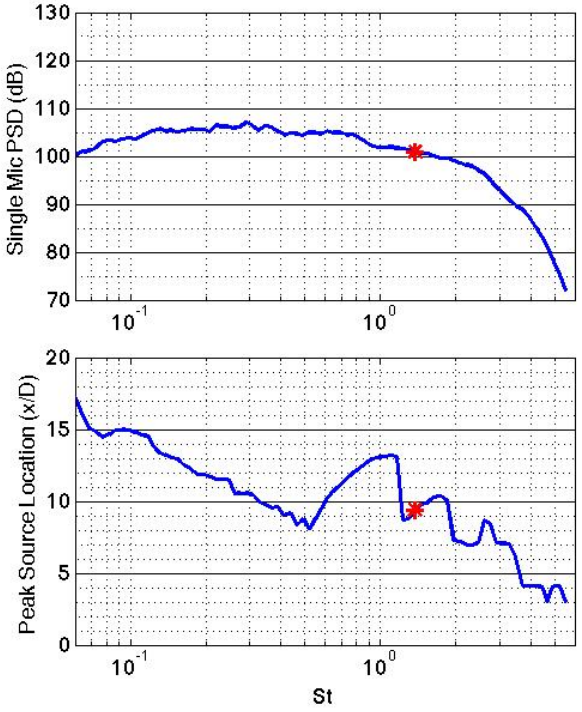

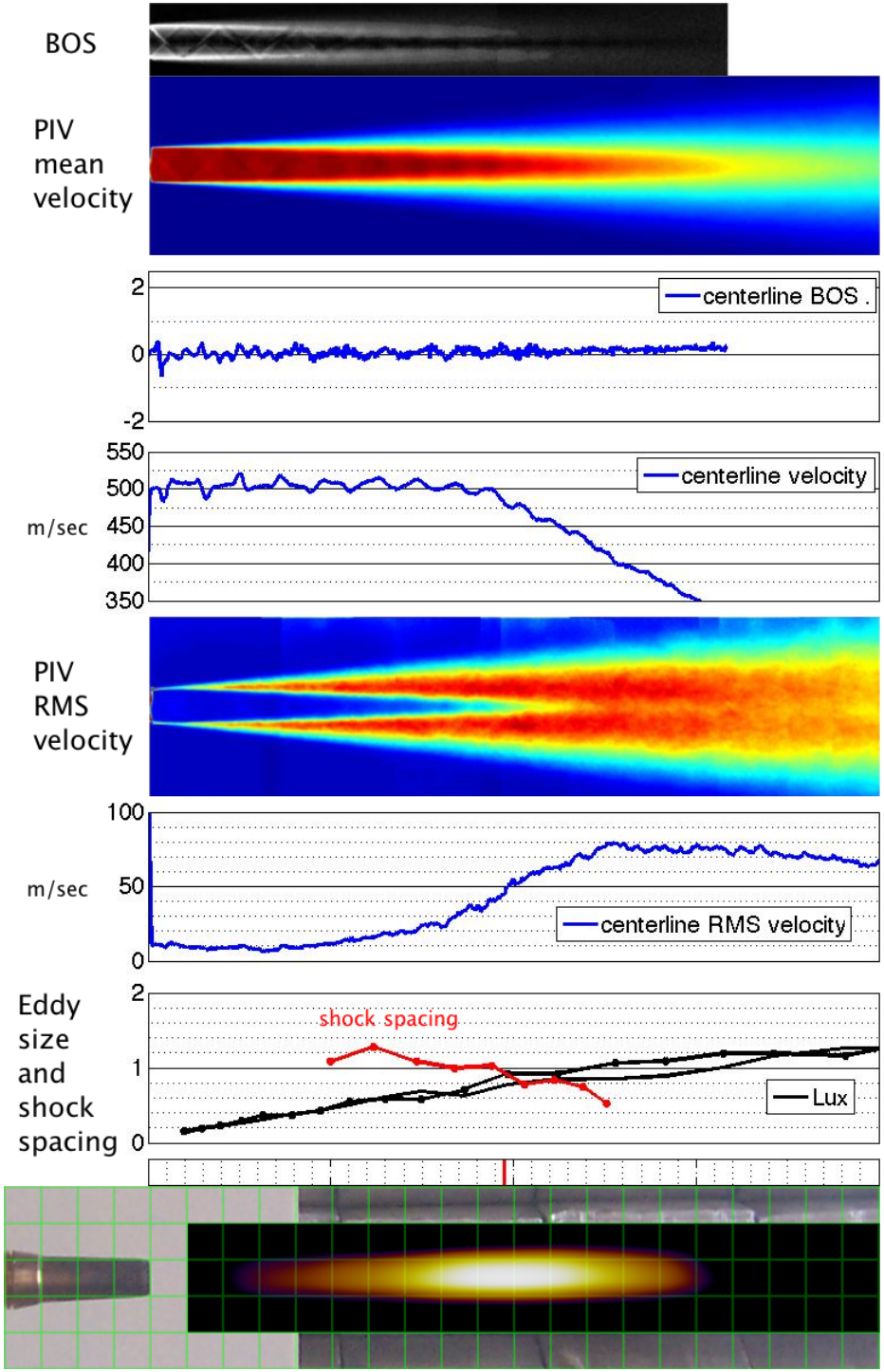

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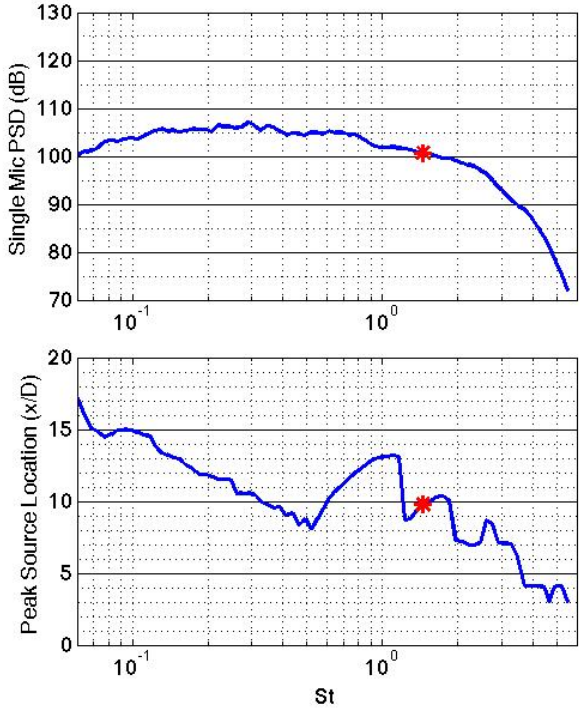

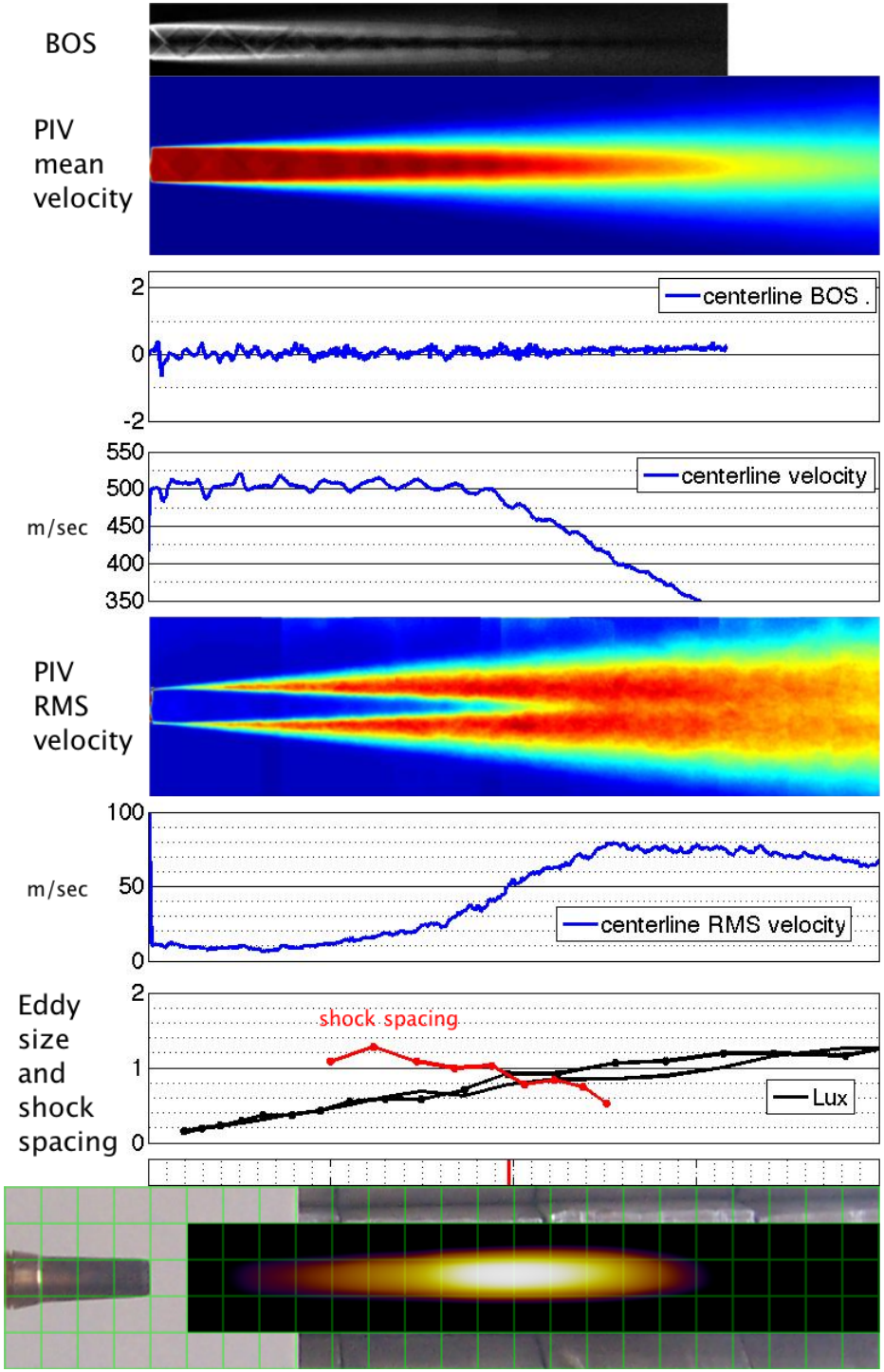

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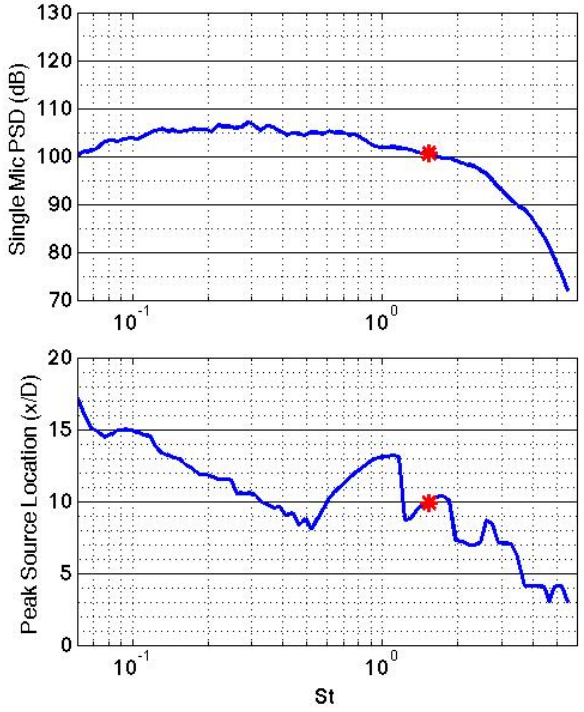

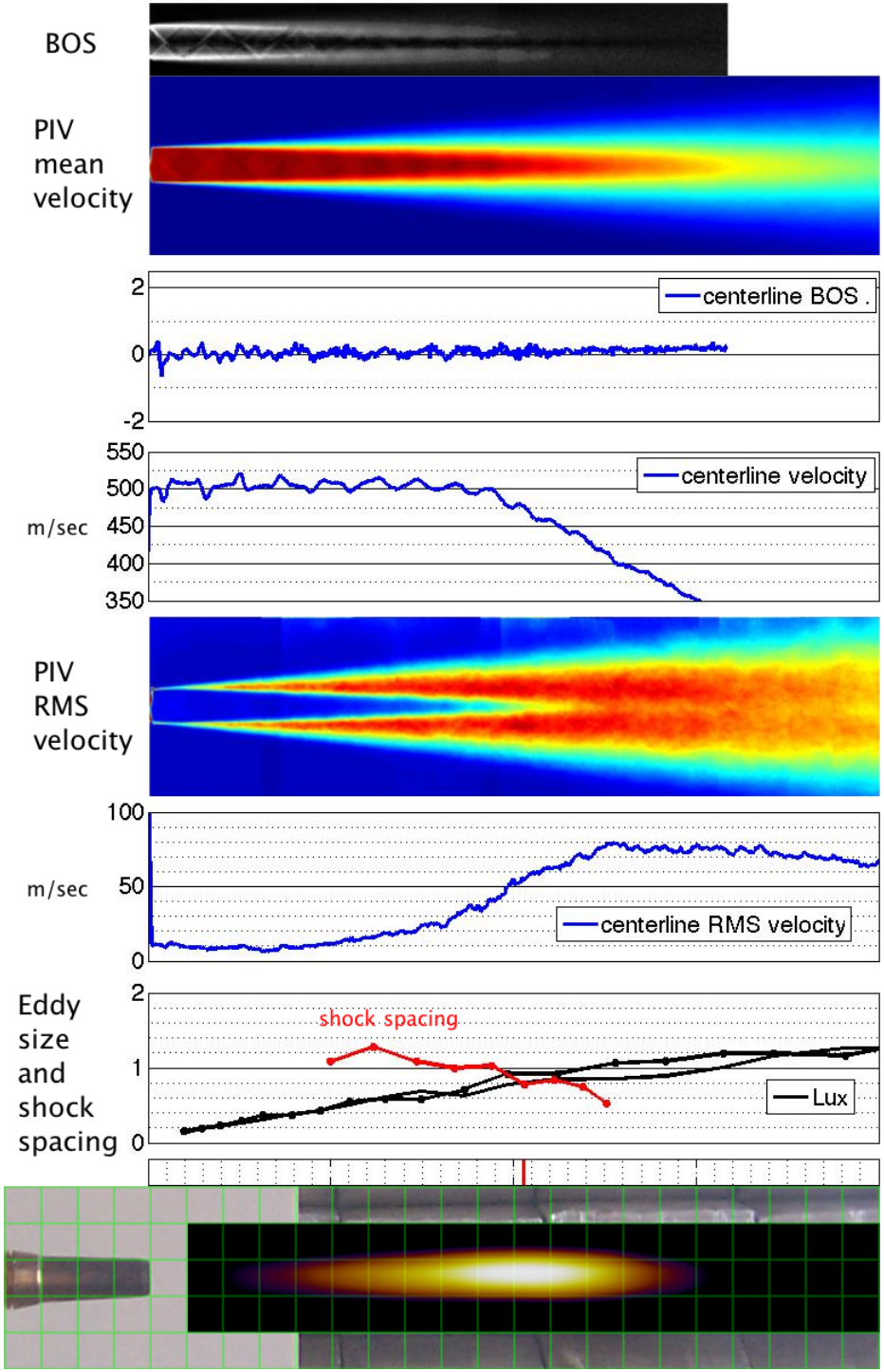

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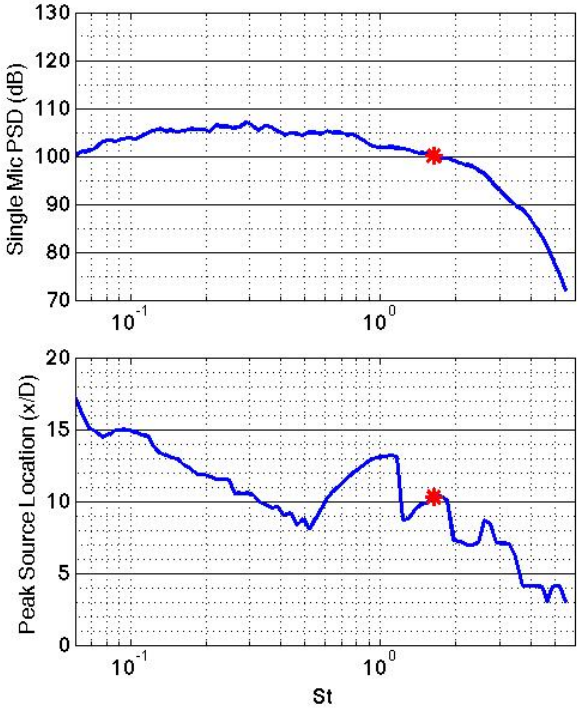

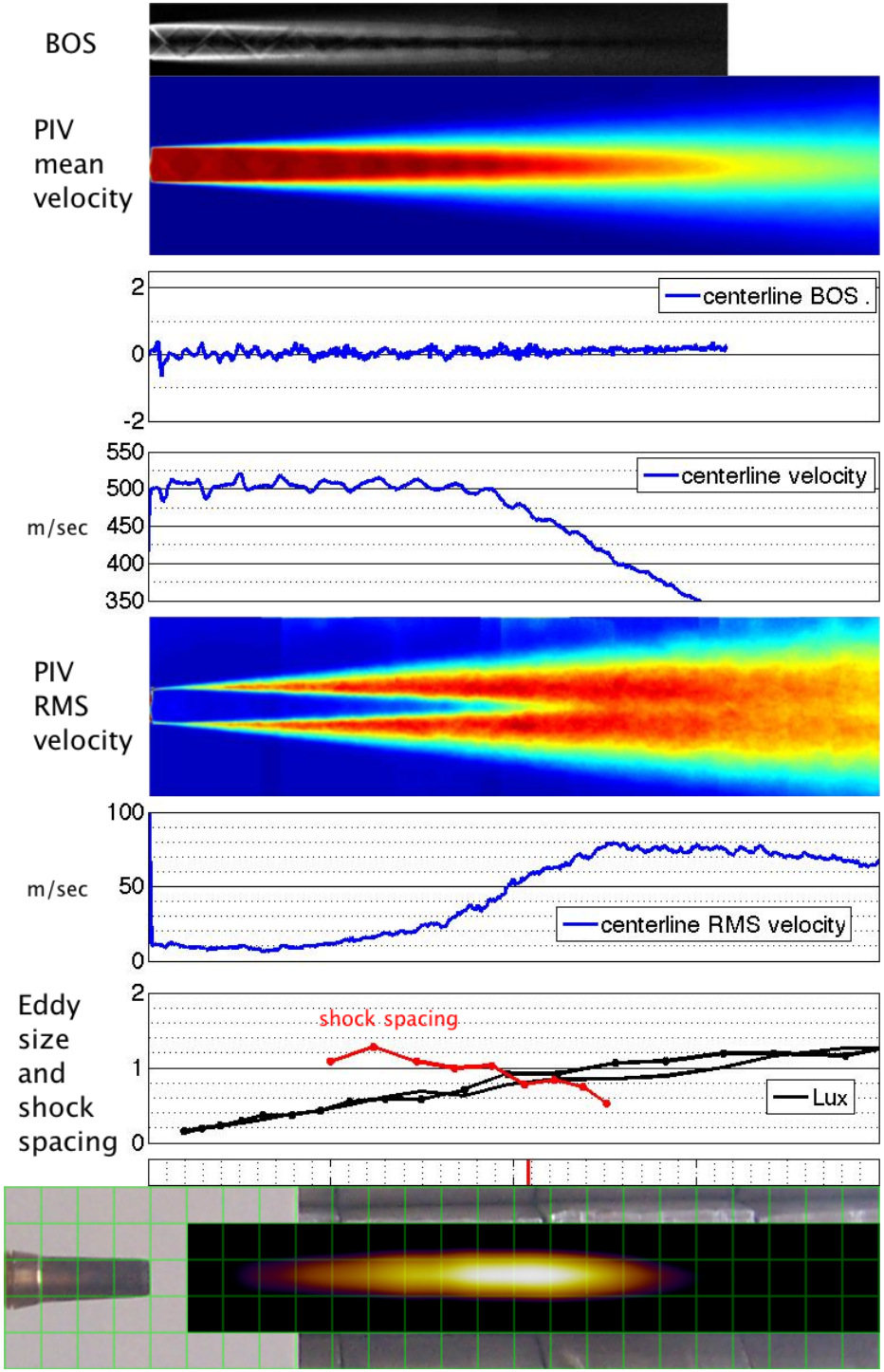

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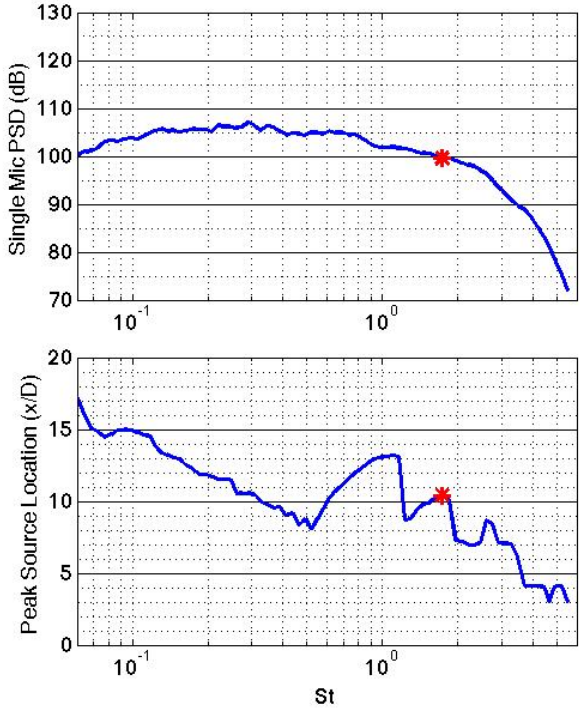

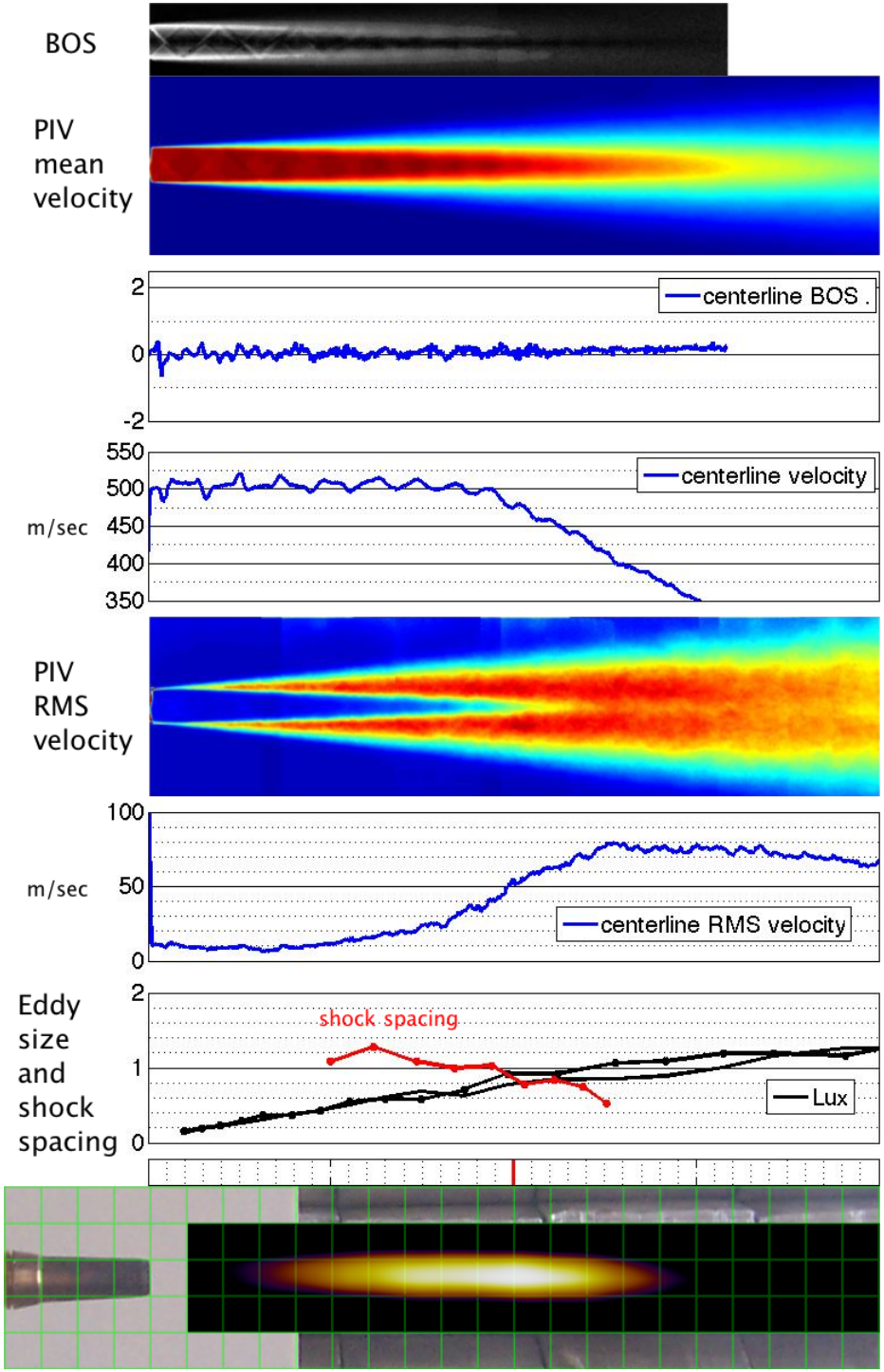

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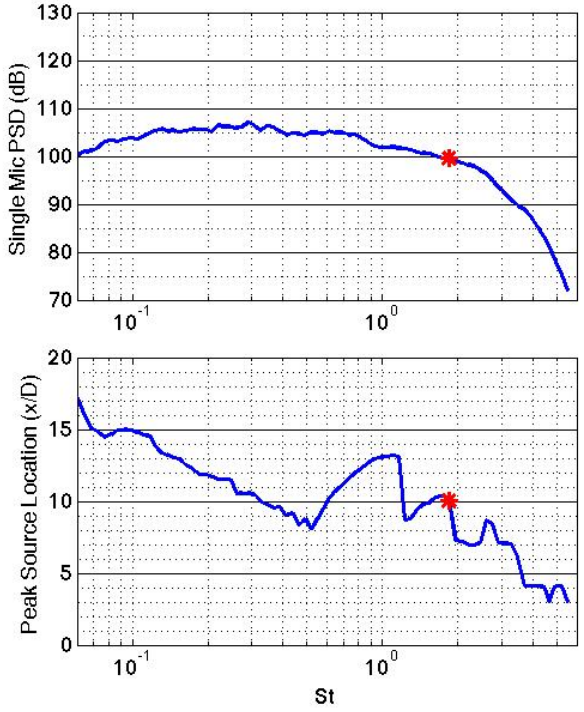

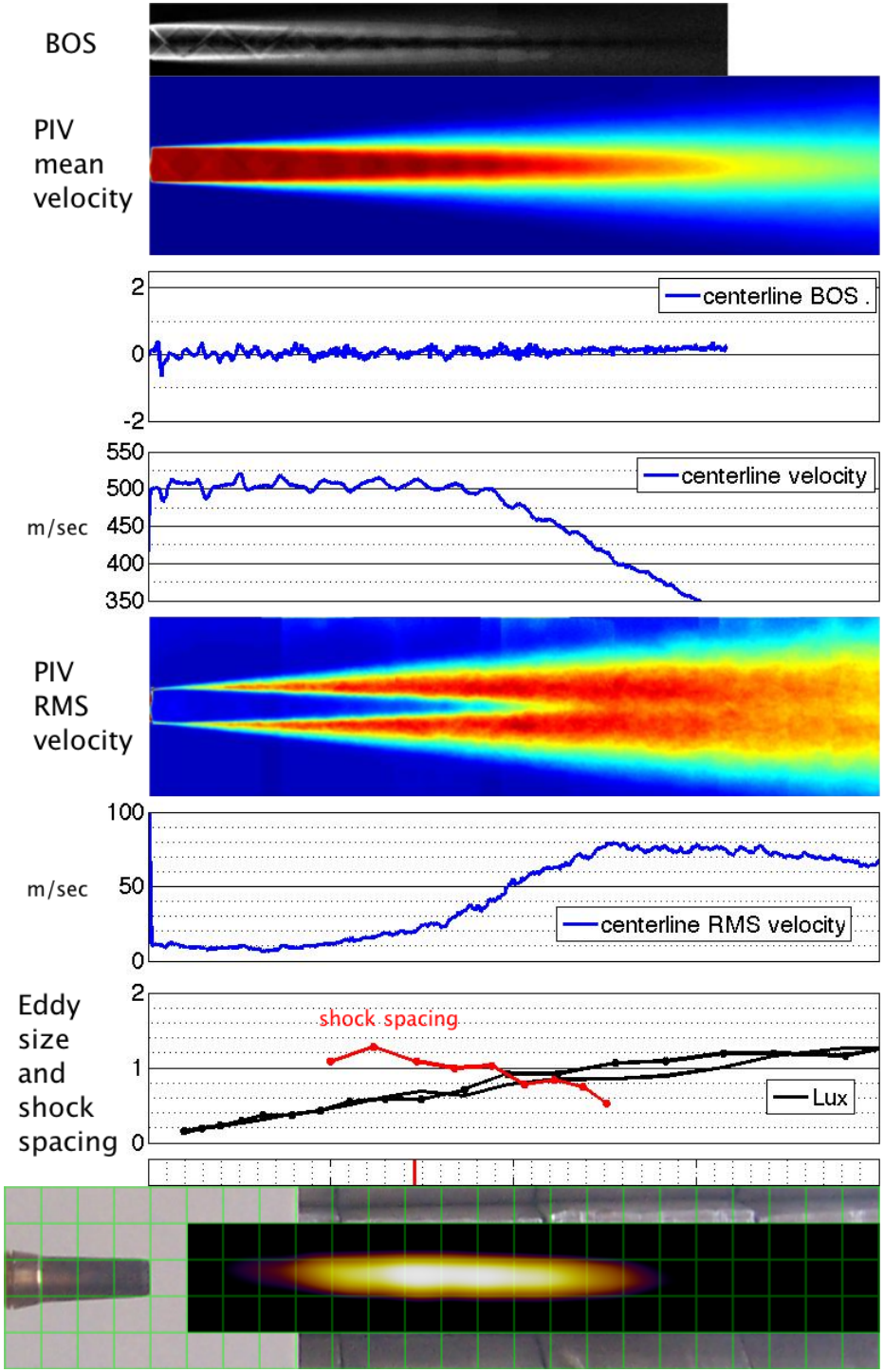

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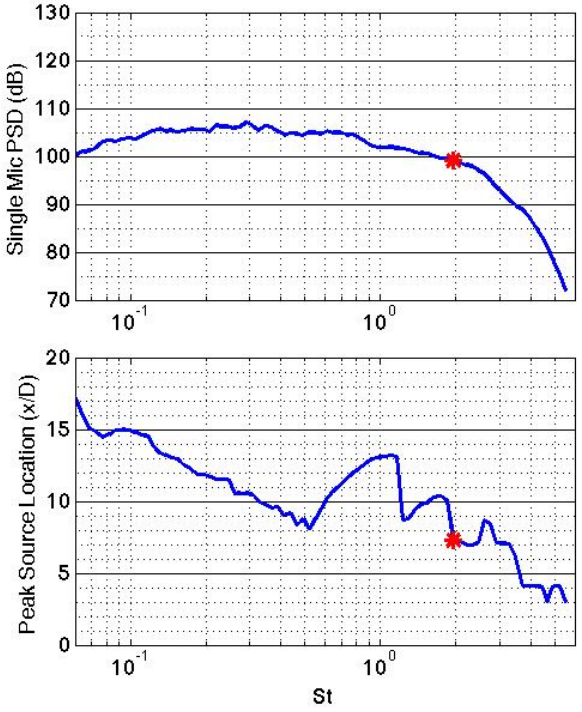

Summary

Phased array noise source localization have been compared with 2 types of flow field data (BOS and PIV).

The data show that

1) the higher frequency noise in a BBSN hump is generated further downstream than the lower frequency noise. This is due to a) the shock spacing decreasing and b) the turbulent structure size increasing with distance downstream

2) BBSN can be created by very weak shocks.

3) BBSN is not created by the strong shocks just downstream of the nozzle because the turbulent structures have not grown large enough to match the shock spacing.

4) The point in the flow where the shock spacing equals the average size of the turbulent structures is a hot spot for shock noise.

5) Some of the shocks responsible for producing the first hump also produce the second hump.